AMRL-TR-79-102

(12) LEVEL II

LONGITUDINAL STUDY OF HUMAN HEARING: ITS RELATIONSHIP TO NOISE AND OTHER FACTORS
II. Results From The First Three Years

ALEXANDER F. ROCHE
JOHN H. HIMES
ROGER M. SIERVOGEL
FELS RESEARCH INSTITUTE
800 LIVERMORE STREET
YELLOW SPRINGS, OHIO 45387
DANIEL L. JOHNSON
AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY

NOVEMBER 1979

JOINT EPA/USAF STUDY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AF AEROSPACE MEDICAL RESEARCH LABORATORY

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

80 2 20 009

NOTICES

TECHNICAL REVIEW AND APPROVAL

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Regulation 169-3.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

HENNING E. VON GIERKE
Director
Biodynamics and Bioengineering Division
Air Force Aerospace Medical Research Laboratory

AIR FORCE/56780/6 February 1980 — 300

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AMRL-TR-79-102	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): LONGITUDINAL STUDY OF HUMAN HEARING: ITS RELATIONSHIP TO NOISE AND OTHER FACTORS II. Results From the First Three Years.	5. TYPE OF REPORT & PERIOD COVERED: Final 15 April 1977- 15 May 1979
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Alexander F. Roche, John H. Himes, Roger M. Siervogel, Daniel L. Johnson*	8. CONTRACT OR GRANT NUMBER(s): F33615-77-C-0516
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Fels Research Institute, 800 Livermore Street, Yellow Springs, Ohio 45387	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62202F 72310809
11. CONTROLLING OFFICE NAME AND ADDRESS: *Air Force Aerospace Medical Research Laboratory, Aerospace Medical Division, Air Force Systems Command, Wright-Patterson AFB, OH 45433	12. REPORT DATE: November 1979
	13. NUMBER OF PAGES: 225
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DTIC ELECTE FEB 21 1980 S D B

18. SUPPLEMENTARY NOTES

Supported in part by Environmental Protection Agency
AMRL-TR-76-110 (ADA-040168) is part I of this report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Hearing Loss
Noise Exposure
Auditory Thresholds
Longitudinal
Noise

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Analyses have been made of serial data from children aged 6 to 18 years; these data relate to auditory thresholds and noise exposure obtained from questionnaires and dosimetry records. For these children, there are serial data for body size, maturity, otological histories and inspections, and medical histories.

The mean thresholds tend to be lower than audiometric zero (ANSI-1969)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

387614

20. continued

except at the higher frequencies. Girls tend to have lower thresholds than boys at all ages. The thresholds tend to decrease with age and to be higher when there are abnormal otological findings. The changes in thresholds (increments) for 6-month periods are normally distributed with means near zero except at the higher frequencies where the changes are in the direction of poorer hearing. This effect is more marked in the older children. The data from the questionnaires indicate total noise exposure increases with age, particularly in boys. However, these estimates of daily noise exposure are not closely correlated with dosimetry data. Auditory thresholds are higher for those exposed to particular sorts of noise with the strongest trends being for those exposed to loud T.V. or power tools. Rapid maturation and stature are associated with lower thresholds. Also, systolic blood pressure is significantly correlated with thresholds but this association is positive in boys and negative in girls.

SUMMARY

This report describes a serial study of auditory thresholds in children 6 to 18 years of age. In addition, data have been obtained from 29 participants examined as youths and examined again after the age of 18 years; the analysis of these data is not included in the present report. Hearing level thresholds, together with detailed information from noise exposure, otological, recreational, and medical histories, and 24-hour dosimetry records of noise for some individuals and data relating to physical size and maturity, and findings from otological inspections are obtained serially from a group of Southwestern Ohio children and youth. The data base includes 1110 satisfactory sets of auditory thresholds and 1278 sets of questionnaires. Serial data for thresholds obtained at 6 visits for each individual are available from 106 participants; the number who have been examined 1 to 5 times or 7 times varies from 14 to 31.

The major aims of the study are to determine the variation among children in patterns of change in thresholds with age and to analyze the relationships between these changes in thresholds and environmental and biological factors. The present report includes a description of the design of the study (a more complete account is available in AMRL-TR-76-110) and analyses of the data collected in the first 3 years of the study.

Satisfactory auditory threshold examinations have been obtained since 26 January 1976, after initial difficulties with audiometric test equipment. The data analyzed in this report were collected through 15 February 1979. The means of the recorded thresholds are near but slightly below audiometric zero (ANSI-1969) for the lower tonal frequencies, but are 2 to 3 dB higher at 4000 to 6000 Hz. The older participants (12 to 17 years) have lower mean thresholds at all frequencies than the younger ones (6 to 11 years) and age is negatively and significantly correlated with thresholds. Perhaps hearing ability increases with age, or perhaps older children are more able to perform the testing tasks. In general, the mean and median thresholds are 2 to 6 dB lower than those recorded in U.S. national surveys for children of the same age and sex. There are indications some abnormal otological findings are associated with hearing loss and that while auditory thresholds decrease in girls during adolescence, thresholds in boys tend to increase during adolescence, especially at higher frequencies. Lateral differences in thresholds are

relatively common and occasionally large; large lateral differences in threshold increments were not observed.

Six-month increments (n = 723) in thresholds were obtained on 251 children; each participant has from 1 to 6 increments. The threshold increments are distributed normally with means of zero at the lower frequencies. However, at 4000 and 6000 Hz, the increments are significantly different from zero in the direction of poorer hearing. This effect is most evident in the older participants, although their overall mean thresholds are lower. This is in general agreement with the view that noise is an important determinant of the auditory thresholds of children. The data indicate girls have slightly lower mean thresholds than boys, which may reflect behavioral differences; boys have more noise exposure than girls. Although the thresholds decrease significantly with age, 6-month increments do not.

Quantitative scores have been derived from total noise exposure histories (n = 259) and interval noise exposure histories (n = 1019). The total noise exposure histories refer to the total period preceding the time when each history was taken; the interval noise exposure histories relate to noise exposure since the previous record (either a noise exposure history or an interval noise exposure history) was obtained. There is an increase in total noise exposure (all sources combined) with age. This change with age is more pronounced in boys. There is, however, little evidence that the interval noise scores are reflective of children's daily noise exposures, as determined by 24-hour dosimetry for selected children.

The associations between noise scores and threshold levels are not significant, although some trends are present. There are statistically significant differences in mean auditory thresholds for participant groups reporting exposure to loud TV, loud stereo, hi-fi, loud vehicles, power tools, and being near or using farm machinery, relative to groups not reporting such exposure. Loud TV and power tools demonstrated the strongest trends.

There is suggestive evidence that rate of maturation is associated with auditory thresholds, such that rapid maturation, especially in girls just before menarche, is associated with lower thresholds (better hearing). Stature is associated with thresholds in a similar fasion, i.e., taller children within the same age and sex group tend to have lower thresholds, irrespective of rate of maturation. These effects are interrelated because rapidly maturing children tend to be tall. There is evidence that systolic

blood pressure is significantly correlated with auditory thresholds, although there is a qualitative difference beween the sexes in this association (boys positive; girls negative). There are no apparent associations between diastolic blood pressure and thresholds, nor between noise scores and blood pressure.

A library of computer programs for the analysis of data from auditory threshold examinations, noise exposure questionnaires, medical histories, and growth and maturation assessments has been developed. This will be used as further data are recorded and it will be expanded to allow the analysis of serial changes by curve-fitting techniques.

There are no previous studies of children dealing with auditory thresholds, and possible environmental, biological and developmental factors that could affect these thresholds. Yet such studies are necessary to determine whether the changes in thresholds observed in cross-sectional surveys are due to marked changes in a sub-sample of children or changes in all children.

The information from the study in relation to the effects of environmental noise on the hearing levels of children and youth will be of great value to the Environmental Protection Agency and the USAF, particularly when the serial data extend until these individuals become adult members of the work force.

This study aims to determine the changes in auditory patterns with age during childhood and into young adulthood and to relate these patterns to environmental and biological factors. The study is appropriate in design and has a great potential to determine the relationships between auditory thresholds, noise exposure and strictly biological variables.

PREFACE

The work described in this report was supported by The Environmental Protection Agency and the Bioacoustics Branch of the Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio.

Special thanks are due to Dr. H. E. von Gierke of the Aerospace Medical Research Laboratory who conceived the need for this project and, after many years of effort, obtained the necessary funding. Considerable assistance has been given also by Captain Mark Stephenson, Lieutenant Terry Fairman and Dr. C. W. Nixon of the Aerospace Medical Research Laboratory. In addition, we are grateful to Mrs. C. Caddell, Mrs. L. Naragon and Mrs. E. Roche, who have recorded the auditory thresholds and collected the questionnaire information and to Mrs. C. Pelzl who collected the dosimetric data. The computer programming and data analysis are the work of Mrs. F. Tyleshevski to whom we are most grateful.

Finally the authors with to thank Miss Nancy Harvey for her help with illustrations and Miss K. Frasure, Mrs. J. Hunter, Mrs. B. Mullins and Mrs. L. Shook, who typed and retyped the manuscript.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

List of Tables Page No.

List of Tables Page No.

List of Tables Page No.

List of Tables | Page No.

List of Tables Page No.

List of Tables | Page No.

List of Tables Page No.

List of Tables Page No.

List of Tables Page No.

List of Tables Page No.

LIST OF ILLUSTRATIONS

List of Illustrations Page No.

List of Illustrations Page No.

List of Illustrations Page No.

List of Illustrations Page No.

List of Illustrations Page No.

INTRODUCTION

Environmental noise can adversely affect people of all ages, but children may require special consideration. One reason is the possibility that children are more susceptible to a loss of hearing ability as a result of noise exposure than adults. Another reason is that children, at various times, may be exposed to particular types of noise that may not be recognized as possibly influencing hearing. The noise exposure of a pre-school child who lives near a busy freeway and often plays outside either at ground level or on balconies overlooking a freeway is an example.

Furthermore, the effect of a marked hearing loss on a child may be more severe than on an adult due to the learning disability to which it may lead. Good hearing ability is necessary for learning and communication, especially in childhood when speech abilities and listening strategies are less well-developed than in adulthood. Even if a hearing loss did not lead to learning disabilities, any permanent reduction in the hearing ability of a child can be considered more significant than a similar reduction in an adult simply because the child can be expected to live longer. Nevertheless, there have not been effective studies of hearing loss in children in relation to environmental factors.

The determination of serial auditory thresholds in the same children, and their analysis in relation to other information, including noise exposure, past health, and maturity, is important if proper and timely decisions are to be made with respect to the control of various sources of environmental noise. Currently, in most analyses of environmental noise impact, it is assumed that occupational noise exposure data from an industrial situation can be applied directly to estimate the effects of noise on children. The validity of this assumption has not been demonstrated.

Auditory thresholds in children are probably positively correlated with the auditory thresholds in the same individuals when adult, although relevant data have not been reported. A convincing demonstration of this requires recording serial auditory thresholds in the same individuals; data at two points in time yielding a single increment for each child are unlikely to provide a convincing answer. Increased knowledge and understanding of the factors that influence hearing levels during childhood, prior to any changes due to occupational noise exposure, will allow better understanding of the significance of the changes in hearing thresholds due to occupational noise exposure. In turn, this should lead to appropriate regulations in regard to important sources of occupational and non-occupational noise, e.g. lawnmowers.

One might ask, "How do we know there is a noise exposure problem with children?" Perhaps the best circumstantial evidence is provided by the data from the Health Examination Surveys conducted by the National Center for Health Statistics (Glorig and Roberts, 1965; Roberts, and Huber, 1970). These crosssectional surveys of large representative U. S. populations show that at 4000 Hz there is no practical difference between the distributions of the hearing levels of boys and girls at age 11 years, but by the age of 18 to 24 years there is a definite worsening in the hearing levels of men while those of women remain unchanged. In fact, one can describe this difference in the statistical distributions of hearing levels at 3000 Hz and 4000 Hz between adult men and women by stating that, in respect of hearing levels, the 20-year-old men have aged about 20 additional years. In other words, the distribution of hearing levels for 40-year-old women is approximately the same as that for 20-year-old men. There is no corresponding effect for thresholds at the audiometric frequency of 1000 Hz.

It should be stressed that these National Surveys were cross-sectional. They provide excellent sets of national reference data, but they cannot provide information about changes within individuals. The sex differences in the National Survey data require further documentation, the distribution of changes within individuals must be established and these changes must be related to possible environmental and biological causal factors. Potential biological factors include previous illnesses, otological status, body size and rate of maturation.

An unresolved question is, "Why does this difference occur between men and women at 3000 Hz and 4000 Hz?" Possible noise exposure is greater for teenage boys than for girls, but proof is lacking that this is responsible for the difference. Other factors might account for all or part of the difference. There could be sex-associated differences in susceptibility to noise, or sex-associated differences in the way in which normal hearing develops irrespective of noise exposure. Furthermore, health-related factors could influence the distribuiton of hearing thresholds at the age of 18 years. This study was planned to answer such questions. From occupational noise exposure data and laboratory studies, it is known that the auditory frequencies from 3000 Hz to 6000 Hz are the most susceptible to typical environmental noise. The maximum levels of exposure acceptable for adults are at least tentatively established. There are no existing data on which corresponding levels for children could be based.

This is the second comprehensive report from the present study. Considerable steps have been taken to obtain some, but not all, the answers needed. Audiometric data have not been recorded over long enough time spans to allow the fitting of complex curves (components in age) to sets of serial data for individuals. At the most, 6 or 7 audiograms have been

obtained for any single participant at 6-month intervals. The data currently available, do, however, allow detailed analyses of individual variations in susceptibility to various environmental factors such as noise. The development of individual hearing threshold patterns cannot be assessed, however, without more serial data points for the individuals already included in the study. Since the commencement of the study about 40 of the participants have passed the age of 18 years. These individuals are being tested at biannual intervals and data are being collected that correspond to those collected from the younger participants in the study.

This report provides a cross-sectional data base together with analyses based on increments. Auditory thresholds of the population studied are related to data from detailed total noise exposure histories (total exposure to time of record), interval noise exposure histories (noise exposure since the previous history was obtained; usually a 6-month period), noise exposure measured with dosimeters, health histories, otological inspections, anthropometric examinations, and assessments of maturity. The auditory threshold levels found in the present study are compared with those reported by others. These analyses show that when more data become available during the continuation of the study, and when curve fitting techniques are applied to longer runs of serial data, it is reasonable to expect a significant contribution will be made to understanding the development of hearing and the quantitative effects of environmental noise on the auditory thresholds of children.

BACKGROUND

HEARING ABILITY IN CHILDREN

Ciocco and Palmer (1941) conducted a large scale investigation of 13,982 school children in Washington, D.C. Unfortunately, most of their observations were made using a phonographic audiometer to test the hearing ability of the children, in groups of about forty. There is ample evidence this procedure lacks specificity and sensitivity, and that it is unreliable (Fowler and Fletcher, 1926, 1928; Rodin, 1927, 1930; Laurer, 1928; Burnap, 1929; Freund, 1932; Rowe and Drury, 1932; Partridge and MacLean, 1933; Rossell, 1933). Ciocco and Palmer (1941) did, however, obtain air conduction thresholds for about 1400 of their group (700 with hearing losses and 700 normal on testing with the phonographic audiometer). Also, they retested some children after intervals of 3 and 5 years. They did not report distribution statistics for thresholds but classified the audiograms into groups. A loss at high frequencies was common and often bilateral. Abnormal records were more common at older ages, and more common in boys than girls for high frequencies.

Jordan and Eagles (1963) studied 4078 school children who were broadly representative of all school children of that age in the Pittsburgh area, except that non-whites were somewhat over-represented. In this group, the median thresholds were lower than the 1951 American Standard Audiometric Zero especially at low frequencies. However, when adjusted using ANSI-1969 standards the median threshold values are all well above zero. There were only slight differences in thresholds between whites and non-whites, and between boys and girls. There was an increase in hearing acuity to about 12 years, after which the cross-sectional data show a loss in hearing acuity. This change occurred about one year earlier in girls than boys, indicating that rate of maturation might be involved directly or indirectly. Jordan and Eagles did not attempt to establish any relationships between auditory threshold levels and noise exposure.

Roberts and Huber (1970) reported population estimates for auditory threshold levels in the United States for chldren aged 6 to 11 years. The data were obtained by individual air conduction testing with pure-tone audiometers. The data were reported with reference to the 1951 American Standard Audiometric Zero; in the present review, they have been adjusted to compensate for the differences between this standard and ANSI-1969. The median thresholds reported by Roberts and Huber (1970) are very close to those from the Pittsburgh study of Jordan and Eagles (1963). In these cross-sectional data, there

is a decrease in auditory thresholds with increasing age during the age range 6 to 11 years, especially at lower frequencies (Roberts and Huber, 1970). This may reflect differences in levels of attention or the fit of the ear phones rather than auditory function.

Roberts and Ahuja (1975) reported corresponding national estimates for auditory thresholds in United States youths aged 12 to 17 years. Using the ANSI-1969 set of zero values, substantially less than half the youths have thresholds below zero; only at 1000 and 2000 Hz do about half the youths reach this level. The thresholds increase with frequency; this increase is rapid in the 2000 and 6000 Hz range as progressively older ages are considered. In youths aged 12 to 17 years, the median thresholds change little with age in girls. In boys, however, there are gradual decreases, particularly at 6000 Hz (Roberts and Ahuja, 1975). These higher frequencies are particularly important in speech perception (Kryter, 1963; French and Steinberg, 1947; Machrae and Birgden, 1973; Suter, 1978). It should be noted that, as in the survey of 6 to 11-year-olds (Roberts and Huber, 1970), these observations were made using audiometers calibrated in 5 dB steps. Also, Lipscomb (1972, 1972a) reported a dramatically higher prevalence of high school and college students failing audiometric tests at high frequencies compared with sixth grade students. Recently, in a study of children in North Carolina, Berger and others (1977) reported that thresholds tended to be higher in boys and higher in rural than in urban groups. In both groups, however, the means were higher than ANSI-1969 zero levels.

Glorig and Roberts (1965) reported population estimates for auditory thresholds in United States adults. Data from the youngest age group (18-24 years) are relevant to the present study.

An increase in hearing acuity from 3 to 15 years in cross-sectional data has been reported (Black, 1939; Kennedy, 1957). It is not clear whether such changes represent biological changes only or whether they reflect better ability to follow instructions and/or better fit of the earphones in older children.

Carter and others (1978) reported descriptive statistics for auditory thrsholds in 386 school children aged 10 to 12 years in Sydney, Australia. The schools were selected as representative of quiet and noisy environments. In addition to obtaining pure-tone thresholds, they did impedance testing and otolaryngological examinations and used the data to establish reference values for a group free of aural disease and risk factors. In these data, the variance of auditory thresholds changed little with frequency and was similar in each sex for children aged 12 to 14 years, except for a greater variance at higher frequencies in the left ears of boys in the normative groups.

Lenihan and co-workers (1971) reported data from 886 Scottish school children aged 5, 9 or 14 years. They excluded those who were abnormal on an otoscopic examination. In each sex for all age groups, the thresholds were higher at 500 Hz than at higher frequencies up to 4000 Hz. The means decreased with age in the boys. In the girls, the means did not change from 5 to 9 years, but they decreased from 9 to 14 years.

SEX-ASSOCIATED DIFFERENCES

Median thresholds are slightly lower in girls than boys at ages 5 to 14 years (Jordan and Eagles, 1963). Ciocco and Palmer (1941) reported hearing losses are about 2.5 times more common in boys than girls at high frequencies. Because this difference is present at each age, they considered factors associated with puberty could not be responsible.

Roberts and Ahuja (1975) found that in youths aged 12 to 17 years, median thresholds are higher for boys than girls although these differences, based on the better ear, are very slight at 1000 and 2000 Hz. These sex-associated differences increase with age at the higher frequencies (4000 and 6000 Hz). Roberts and Huber (1970), however, did not find sex differences in the 6 to 11 year age range.

Cozad and others (1974) reported a survey of 18,600 Kansas school children aged 6 to 18 years. Hearing loss was more common in boys than girls at all ages; the prevalence of hearing loss increased with age in the boys but not the girls. Most of the hearing losses occurred at higher frequencies. There were no significant lateral differences. Others have reported similar findings indicating that hearing losses are more common in boys than girls (Kodman et al., 1957; Lipscomb, 1972).

DOSIMETRY

There do not appear to be any reports of auditory thresholds in children in relation to noise measured with dosimeters.

RACE

Roberts (1972) reported that white children, aged 6 to 11 years, have lower thresholds than Negro children at frequencies of 1000, 2000 and 4000 Hz. At lower and higher frequencies, Negro children have slightly lower thresholds than the whites.

Roberts and Ahuja (1975), in a national survey of youth aged 12 to 17 years, reported that white youths have lower thresholds than Negro youths at frequencies of 1000, 2000 and 4000 Hz, but not at 500 and 6000 Hz; these differences are small (0.6 to 1.4 dB) but all are statistically significant, except that at 500 Hz.

DEMOGRAPHIC CHARACTERISTICS

Preschool children from lower socioeconomic groups make more errors in auditory discrimination tests than more privileged children, even after the effects of chronological age and intelligence quotient are partialled out (Clark and Richards, 1966). The possible factors (e.g., illness, nutrition, motivation) were not elucidated.

Roberts and Ahuja (1975) found no consistent pattern of differences in auditory thresholds dependent upon size of place of residence. The thresholds tend to be higher in low income groups and in groups with low levels of parental education. Similar findings were obtained in other surveys of children and adults (Roberts and Huber, 1970; Glorig and Roberts, 1972). For U. S. children, youths living in the South have higher auditory thresholds and more hearing problems than those living in other areas (Roberts, 1972). In the sample studied by Carter and his associates (1978), however, socioeconomic status and the mothers' country of origin had little association with auditory thresholds.

OTOLOGICAL EXAMINATION

Ciocco and Palmer (1941) reported that serial changes in thresholds are related to the later state but not the earlier state of the tympanic membrane and that this relationship occurred at medium frequencies only.

Roberts and Federico (1972) reported data concerning the prevalence of ear, nose and throat abnormalities and their relationship to hearing threshold levels and medical events. The data were obtained from a national probability sample of 7119 children and were weighted to obtain national estimates for the United States. The prevalence of abnormalities was obtained by averaging the prevalence for the two sides. The external audiotory meatus was completely occluded in 7.2 percent, the drum was invisible in 10 percent, dull in 5.7 percent, bulging in 0.3 percent, red in 1.2 percent and perforated in 0.4 percent of ears. These authors reported higher thresholds in children with a history of earache (difference from normal about 1.5 dB), in those with perforated drums (difference about 2 dB), in those with running ears (difference about 1.5 dB) and in those with abnormal or red drums (difference about 3 dB). Others (Ciocco and Palmer,

1941; Jordan and Eagles, 1961, 1963; Eagles et al., 1967) have reported that when the tympanic membrane is abnormal on examination, the auditory thresholds tend to be higher by 2 or 3 dB and, if it is perforated, the auditory thresholds are from 12 to 15 dB higher.

Carter and others (1978) reported significantly higher thresholds and increased variance in those with abnormal ears or at risk because of their medical history. The effect of removing such children from a sample on the observed distributions of auditory thresholds was shown clearly in a substantive review by Robinson and Sutton (1978).

LATERAL DIFFERENCES

Jordan and Eagles (1963) and Ciocco and Palmer (1941) reported a lack of systematic lateral differences in auditory thresholds. This is in agreement with the findings of others (Kodman et al., 1957; Lenihan et al., 1971; Carter et al., 1978). Glorig and his co-workers (1957) reported, however, that the right ear thresholds were lower than the left in boys at most frequencies although girls had lower thresholds at the higher frequencies. Similarly, Kodman and Sperazzo (1959), in a study of 1000 children with signficant hearing loss, found losses were more common in the left than the right ear in each sex.

Roberts and Huber (1970) found no tendency for hearing to be better on a particular side in children aged 6 to 11 years. They did find the magnitude of lateral differences increased with the frequency of the tone. The lateral differences found in youths aged 12 to 17 years in the survey of Roberts and Ahuja (1975) also increase at higher frequencies. The differences are larger than those found in younger United States children, aged 6 to 11 years (Roberts and Huber, 1970) and adults (Glorig and Roberts, 1965). Furthermore, in those aged 12 to 17 years, the left ear tends to have the poorer hearing. There was a similar pattern among the adults included in the national survey by Glorig and Roberts, (1965).

AUDITORY THRESHOLDS AND NOISE

Although it has been suggested children are more susceptible than adults to temporary threshold shifts at the same frequency as a tone presented at 100 dB, the data are inconclusive, in part, because the thresholds have been tested too soon after the stimulus (Hirsh and Bilger, 1955; Harris, 1967; Fior, 1972). Others have suggested the ears of the young are less susceptible to noise-induced hearing loss than are the ears of the adults (Wageman, 1967).

Temporary threshold shifts under identical experimental conditions are less in 7-year-old children than in 12-year-old children or young adults, but the younger subjects recover more slowly (Ward et al., 1958; Hétu et al., 1977). There is experimental evidence, however, that exposure to loud noises causes more histological damage in young than in adult guinea pigs (Jauhiainen et al., 1972) and that kittens lose more sensitivity than cats when exposed to intense sound (Price, 1976). It has been suggested permanent changes in thresholds due to noise are noted first in boys aged 16 to 18 years and that firearms and farm machinery are the usual sources (Weber et al., 1967; Litke, 1971). There may be a relationship between age and the sensitivity of hearing ability to noise among adults (Kup, 1966; Nowak and Dahl, 1971, 1971a).

Temporary threshold shifts in children and adolescents have been reported after exposure to the noise associated with toy cap guns (Marshall and Brandt, 1974), model airplanes (Bess and Powell, 1972), snowmobiles (Bess and Poynor, 1972) and rock and roll music (Rintelmann et al., 1971; Ulrich and Pinheiro, 1974; Hanson and Fearn, 1975). Hanson (1975) in a study of young adults (age range 18 to 25 years) found statistically significant losses in hearing ability among those who admitted frequent attendance at pop music entertainment. The loss is larger at 2000 and 4000 Hz than at other frequencies.

In a study of 230 university students and 200 clerks aged 16 to 20 years, Carter and others (1977) found an extremely low prevalence of aural disease and little or no hearing loss attributable to noise. These workers (1975, 1976), in their study of 10- to 12-year-old children, found no evidence environmental noise affected hearing ability.

Cohen and others (1973) reported a correlation study of children living in apartments. The analyses were based on floor level (which had rather high negative correlations with noise) and subsets of intelligence tests. The coefficients between floor level and test performance were positive, large and significant in those living in the apartment 4 years or longer; they were not significant for those living in the apartment for shorter periods. A stepwise regression using data from those who had been in the apartment 4 years or more showed floor level was more important in regard to auditory discrimination than father's education, number of children in the family or grade level. The authors concluded the duration of residence in the apartment, and, therefore, the duration of the noise was related to the impairment of auditory discrimination and that this led to learning handicaps.

This conclusion may be correct, but one cannot be sure in the absence of serial data. One question in particular remains unanswered: did the children differ in hearing ability before they came to live in the apartment house? As pointed out by Mills (1975), the correlation between hallway noise near windows overlooking an expressway and auditory discrimination was high but that between expressway noise level and the noise levels within the apartments was considerably lower. Furthermore, it is unreasonable to assume that the total noise exposure of the children occurred within the apartment building.

NOISE AND BLOOD PRESSURE

Reports concerning vibrations are relevant to the possible associations between noise and blood pressures. Unfortunately there is disagreement between the few reports available. Fenhein and Shakir (1977) reported a lack of real changes in blood pressure when large vibrating pads were worn; others have reported increases with whole body vibration (Hood and Higgins, 1965). Tysare (1967) found vasoconstriction when adolescents were exposed to noise in combination with vibration.

There are few, if any, convincing studies of children although there have been many reports of associations between noise exposure and blood pressure in industrial workers. Takala and others (1977) in Finnish men aged about 46 years found no difference in blood pressure between those who had a noise-induced type of hearing loss and those who did not. Hedstrand and others (1977) in a study of 2002 subjects found no significant difference in blood pressure between the 393 with a noise-induced hearing loss and the remainder. There is, however, some contrary evidence. Andrukovich (1965), in 846 women textile workers aged 16 to 49 years, exposed to intensities of 80 to 102 dB, found higher blood pressures than in a control population. Chemin and others (1970) claimed intermittent noises caused an increase in blood pressure but that the change was smaller than with continuous noise. Exposure to noise is associated also with increased diurnal variations of blood pressure (Pokroskii, 1966). Fakhre and others (1976) reported an extensive study of older adults in Egypt. The found that essential hypertension was associated with a loss of hearing ability and concluded that blood pressure had a significant effect on hearing but noise had no such effect. Jonsson and Hansson (1977) reported a study from Sweden of 196 male industrial workers. Those with a noise-induced hearing loss had higher blood pressures. The difference was highly significant and was not due to an age difference between the two groups. There could be a genetic element in such changes; young prehypertensive spontaneously

hypertensive rats show a more pronounced rise of blood pressure after stressful stimuli than normal rats (Hällback, 1975).

Krasilschikor (1967) reported industrial workers exposed to loud noise had decreases in blood pressure and pulse rate towards the end of the shift. If ear protectors were used these effects did not occur. Ponomacenko (1966) reported data from industrial situations in which there was a stable high frequency noise of 85 dB mainly at 1000 to 2000 Hz. Adolescents had decreases in blood pressure during the working day. Similar findings have been reported by others (Pokrovskii, 1966; Meinhart and Renker, 1970; Maksimova et al., 1974; Kachny, 1977) but this effect tends to reverse with increasing time on the job (Kachny, 1977).

SERIAL FINDINGS

Ciocco and Palmer (1941) reported findings for school children reexamined for pure-tone air conduction thresholds after intervals of 3.5 (N = 543) and 5 years (N = 552). About half of each group had been selected as having a probable hearing loss, and about half as being normal after group testing with a phonographic audiometer. There were marked differences between pairs of records; for example, 90 percent of the pairs separated by 3.5 years differed by 5 dB or more. The changes tended to be greater at high frequencies and similar in each ear. Eagles and others (1967) found a marked tendency for serial thresholds to decrease.

Wishik and others (1958) reported serial data for children examined when aged 5 to 6 years and again when aged 12 to 13 years. They were classified as passing or failing a pure-tone test of auditory thresholds. Among those who passed at the first examination, about 1 percent failed at the second examination whereas among those who failed at the first examination, about 30 percent passed at the second examination. Peckham and Sheridan (1976) reported a follow-up study of 46 children with severe unilateral hearing loss at the age of 7 years who were reexamined when aged 11 years; half had recovered.

There is a need for serial data relevant to the damaged ear theory (Ward, 1976). According to this theory, ears with hearing loss are more likely to show further loss on exposure to noise than are ears without hearing loss; there is some doubt about the validity of the theory but it appears that ears with changes (temporary threshold shifts) may be more susceptible to permanent changes.

HEARING AIDS

Powerful hearing aids may produce marked threshold shifts in the direction of hearing loss in children (Kinney, 1961; Macrae and Farrant, 1965; Macrae, 1968, 1968a; Roberts, 1970). This may be related to the cause of the hearing loss. It has been reported that losses are greater in the aided ears of children with deafness due to meningitis but not in those in whom the deafness is due to maternal rubella or perinatal causes (Barr and Wedenberg, 1965). It should be noted that only one of the participants in the present study has a hearing loss sufficiently severe to need a hearing aid.

RELIABILITY

The importance of appropriate training for audiometric testing is apparent from the findings of Howell and Hartley (1972). In testing young adults, they reported a mean interobserver difference of 5 dB with differences up to 21.2 dB at 3000 and 4000 Hz. There was a systematic difference between the two observers and their measurements differed significantly in a Wilcoxon's signed rank test. Jordan and Eagles (1963) reported mean interobserver differences of 1.3 to 8.8 dB with the larger differences tending to occur at the lower frequencies. The audiometers used were graduated in 5 dB steps.

SUMMATION

Consideration of the available literature relating to thresholds in children indicates that:

-- hearing acuity tends to increase until 12 years; later there is a small loss in acuity in boys but little change in girls,

-- sex differences in thresholds are slight to 12 years,

-- data from the U.S. indicate auditory thresholds tend to be higher in lower socioeconomic groups; no such tendency is present in data from Australia,

-- auditory thresholds are higher in those with abnormal findings at otoscopic examinations,

-- from 6 to 17 years, white children have lower thresholds than black children at 1000, 2000 and 4000 Hz. At lower and higher frequencies the differences are in the opposite direction and most are not significant,

-- lateral differences tend to increase with age; hearing ability tends to be poorer in the left ear,

-- data relating auditory thresholds to noise exposure are sparse, but there is evidence temporary shifts occur. It has been reported these are less marked in younger children but recovery from them is slower,

-- there is sufficient evidence to support further research into the question as to whether exposure to continuous loud noise is associated with increased blood pressure in industrial worksers. Corresponding data for children have not been reported.

-- serial findings are scarce. Apparently, rapid changes are common, particularly at higher frequencies. Threshold changes are related to the later but not the earlier state of the tympanic membrane, and

-- powerful hearing aids can cause a loss of hearing acuity.

Because so little is known (many of the above statements being tentative), it is essential that auditory thresholds be studied serially in children in relation to the factors likely to be associated with these thresholds, particularly environmental noise. There are no satisfactory studies of hearing loss as a function of age before 16 years, the factors responsible for the development of a sex difference in these levels after 12 years are unknown (it is not even clear whether these factors are biological or environmental) and, finally, it is not known to what level of noise children can be exposed without increases in hearing thresholds. These questions will remain unanswered until there is a serial study based on appropriate types of data collected at many examinations over a sufficient time span. The present study was planned with this in mind. This report describes the design of the study briefly and provides analyses of some data from the first three years. A start has been made, but longer serial records are needed before the most effective longitudinal analyses will be possible.

SAMPLE AND METHODS

SAMPLE

Two groups of children, each approximately equally divided by sex, are being studied. The majority (N = 211) are participants in the Fels Longitudinal Study, who were aged between 6 and 18 years at their first audiometric examination. Due to the expectation that auditory changes within individual children might be more marked during pubescence and early adolescence, it was decided to enroll a group of middle school students from Yellow Springs to increase the sample sizes at these ages. Consequently, 47 children aged 12.5 to 13.5 years at the commencement of the study were enrolled. These students are now attending the Yellow Springs High School. The total study population is 258. Of these, 251 remain active; one died, three moved out of the state, one could not be tested reliably and was dropped from the study, and two have refused further cooperation.

The participants in the Fels Longitudinal Study live in Southwestern Ohio and were born between 1928 and 1973. They were enrolled before birth at the rate of about 15 per year. Their homes are within 30 miles of Yellow Springs, about 35 percent living in cities of medium size (populations 30,000 to 60,000), about half in small towns (populations 500 to 5000) and the remainder on farms. The educational and occupational patterns for these three groups do not follow the usual urban-rural differences. About 15 percent of the fathers are professionals or major executives, 35 percent are businessmen, 35 percent are tradesmen or white collar workers and the remaining 15 percent are skilled or semi-skilled laborers. About 60 percent of the parents attended a year or more of college and about 60 percent of them were born in Ohio. In general, they are of middle socioeconomic level. The middle school children were reasonably representative of the Yellow Springs community; in general they are of middle socioeconomic status. The children in each group are "normal" in the sense that they were not selected because of the presence of any recognized disease or disorder.

DATA COLLECTED PREVIOUSLY

The children in the Fels Longitudinal Study were enrolled into the program prenatally. Data were recorded serially, and continue to be recorded, at regularly scheduled visits that are fixed in timing and are unrelated to the illness experience of the children. Examinations are scheduled for 1, 3, 6, 9, and 12 months and then 6-monthly to 18 years

after which they are made annually to 24 years in boys and 22 years in girls. When the participants visit Fels, radiographs of the left hand-wrist are obtained (for the assessment of skeletal maturity), stature, weight, and other anthropometric dimensions are taken and a detailed medical history is obtained. Until mid-1975, a complete physical examination was made at each visit; this has been replaced by an interval medical history accompanied by the measurement of blood pressure and pulse rate. Consequently, there is a very large body of early and concurrent data for these Fels participants that is relevant to auditory thresholds.

EQUIPMENT

The equipment being used is described in detail in the previous report (AMRL-TR-76-110; Roche et al., 1977). The present description, as it applies to the original equipment, will be brief. An audiometric booth (Tracor RE142B) provides a noise reduction of 44 to 59 dB at the tonal frequencies being tested. The booth is in a very quiet part of the building. At the beginning of the study, there were some problems with the test equipment. As a result, there are doubts about the accuracy of auditory thresholds recorded before 26 January, 1976 and they have not been analysed. The other data (questionnaires, histories, otological inspection, size, maturity), recorded since 12 August, 1975, were, of course, not influenced by these equipment difficulties.

Some dosimetry data have been collected since 2 May, 1978. From 2 May, 1978 to 18 October, 1978, dosimeters from Loomis Laboratories, Bruel and Kjaer, General Radio and Computer Engineering were tried. We were unable to obtain satisfactory results with the Computer Engineering equipment. Due to experience with the other dosimeters, General Radio dosimeters were used exclusively after 18 October, 1978. Recently, the project was provided with two Metrosonics dosimeters; one provides an 8-hour record and the other a 24-hour record. Each record provides the noise exposure during 480 separate periods. The periods are 1 minute for the 8-hour record and 3 minutes for the 24-hour record. Trials with this equipment have shown it to be satisfactory and it is being introduced into the study for use in addition to General Radio dosimeters.

The dosimeters are calibrated before and after each use and the batteries are changed after they have been used twice. The General Radio 1954-9780 Noise Exposure Meter is read and calibrated with the General Radio 1945 Indicator at 116.5 dB and 1000 Hz. The Metrosonics db-301 Metrologger (dosimeter) is calibrated with General Radio Type 1562-A Sound-Level Calibrator at 114 dB and 1000 Hz.

TESTING PROCEDURES

Otological Inspection -- Immediately before a participant's auditory threshold levels are assessed, each tragus, meatus, and ear drum is examined by a research assistant trained to do this work. The findings are recorded on the "Auditory Threshold Level Recording Form."*

Thresholds -- At six-month examinations, thresholds are tested in the order 1000, 2000, 4000, 6000, 1000, 500 Hz with the right ear first. All intensities are measured relative to ANSI - 1969 audiometric zero. In the analysis of data, the second value at 1000 Hz is being used. The testing is done by one observer at each examination, with observers assigned randomly. The threshold is obtained at each frequency by beginning at a low sound intensity and increasing the intensity until the participant signals he or she has heard the tone. The attenuation is then increased by 10 dB and decreased by 6 dB with small increases and decreases to delineate the threshold as accurately as possible. This is repeated three times for each tone in each ear.

The thresholds are recorded in 2 dB steps on the "Auditory Threshold Level Recording Form" Comments about the continuity and completeness of testing and the nature of the responses by the participant are recorded both in general and for each frequency.

Questionnaires -- A set of very detailed questionnaires has been developed to ascertain the level of noise exposure. The data obtained using these questionnaires allow analyses of the relationships between auditory thresholds and environmental factors.

There are two very similar questionnaires:

(i) "The Biographical, Noise Exposure and Otological History" was administered to each participant at the first audiometric examination (Appendix B in AMRL-TR-76-110; Roche et al., 1977). The data obtained by means of this questionnaire concern: personal identification, family structure and occupations, recreational activities, work activities, noise exposure history (guns, toys, hobbies, mechanical equipment, place of residence, TV, music) and an otological history (family and personal information concerning hearing loss, previous testing, infections, discharge, tinnitus). This noise exposure history provides a quantitative noise exposure score for each individual for his lifetime prior to the first examination.

* A copy of this form is included as Appendix A in AMRL-TR-76-110; Roche et al., 1977.

(ii) The "Interval Audiometry Questionnaire" (Appendix C in AMRL-TR-76-110; Roche et al., 1977) is very similar to the otological history part of the preceding questionnaire, and is administered at the second and subsequent audiometric examinations. It contains questions relating to change of address, noise exposure, otological history, changes in general health and the possible occurrence of menarche since the previous visit. The figures written beside the coding squares on this questionnaire are the weightings applied in the computation of the noise scores. The interval noise exposure questionnaire provides a total noise exposure score for each individual for the 6-month interval prior to testing. In addition, the data provide an event score, a chain saw score, and a gun score (Appendix D in AMRL-TR-76-110; Roche et al., 1977). These scores are used to identify those individuals most likely to have been injured by noise exposure. In September 1976, this questionnaire was extended to include information relating to school buses, relationship of testing to underwater weighing (being done in another study) and provide space for recording the blood pressures and pulse rates of the "middle school participants" (Appendix A).

OTHER PROCEDURAL ASPECTS

(i) A visit for audiometric testing alone requires the participant to be in the Institute for about 50 minutes. Because of the large amount of data obtained from each participant, both for this study and for others, some additional visits specifically for the audiometric study have become necessary.

(ii) Skeletal maturity assessments (Greulich and Pyle, 1959; median of bone-specific skeletal ages; interpolating between standards to the nearest 3 months when this appears appropriate) have been made for boys and girls in the Fels Longitudinal Study. These assessments are not made for the middle school participants.

(iii) The stature of each Fels participant is recorded to the nearest millimeter at each examination using a Harpenden stadiometer.

(iv) Some children with a marked hearing loss have been identified and referred to appropriate physicians. Their problems are described under "Hearing Problems" in the RESULTS section.

(v) The observations with dosimeters have been made on 62 of those children willing to participate in this part of the investigation. Each 24-hour record has been obtained after explaining the purpose of the study, the nature of the equipment and details regarding its use to the participant. The next day the participant is visited to obtain a record, by questionnaire, of activities for the 24-hour period during which the dosimeter was worn. The dosimeter is retrieved to record the noise exposure and for calibration. These data are recorded on the General Radio Dosimeter Form (Appendix B) or the Metrosonics Dosimeter Form (Appendix C).

RELIABILITY

The otological history for the Fels participants is highly reliable because these data have been obtained 6-monthly since birth until the physical examinations were replaced by 6-monthly medical histories in mid-1975. Histories obtained over long intervals may be less reliable (Ciocco and Palmer, 1941). Inter- and intra-observer differences have been obtained for thresholds determined on Fels staff. With the present audiometer these differences are small for all frequencies and compare favorably with those reported by others (Table 1). The interobserver differences tend to be smaller than the intraobserver differences, perhaps, in part, due to the longer interval between the latter.

The stature measurements are highly accurate (mean interobserver difference 0.3 cm, s.d. 0.15 cm, N = 420; Roche and Davila, 1972). Technicians assessing skeletal maturity have been trained using a system shown to be satisfactory (Roche et al., 1970) and have reached levels of accuracy equal to, or better than, those reported by experienced research workers and pediatric roentgenologists (Johnston et al., 1973).

PROGRAMMING

Much more computer programming has been necessary than originally envisioned. In part, this has resulted from changes in the computer facility at The Fels Research Institute and, in part, from the analysis of the elaborate questionnaires. The programs available are:

TABLE 1 - REPLICABILITY AND COMPARABILITY DATA RELATING TO AUDITORY THRESHOLDS (dB)

Frequency	Mean	s.d.
Intra-observer differences (n = 10)		
500 Hz	2.80	2.70
1000 Hz	4.40	4.19
1000 Hz	3.80	5.61
2000 Hz	5.60	3.24
4000 Hz	5.20	2.70
6000 Hz	3.80	3.82
Grand mean	4.27	
Inter-observer differences (n = 18)		
500 Hz	2.67	2.28
1000 Hz	3.53	4.61
1000 Hz	4.00	4.85
2000 Hz	3.89	3.72
4000 Hz	4.00	4.06
6000 Hz	3.56	3.40
Grand mean	3.61	

AUDIO -- From user-supplied specifications, this program selects a subsample of all audiometric examinations and computes the following:

A listing of data for each examination sorted by participant identification number and examination date. The listing includes ID number, examination date, birth date, age, sex, examiner, all otological examination comment codes, and auditory threshold levels and/or increments at each tonal frequency for right, left, better and worse ear, as well as the lateral difference. Corresponding data can be obtained for the means of thresholds at 500 1000 and 2000 Hz and the difference between thresholds at 1000 and 4000 Hz.

For each tonal frequency in each ear, a frequency distribution including the level of attenuation, number of individuals, and proportion of the total at that level.

For each tonal frequency, general distribution statistics of thresholds and/or increments in right, left, better and worse ear and lateral differences. These statistics include sample size, mean, standard deviation, gamma one measure of skewness, the significance level of the *t* value for gamma one, gamma two measure of kurtosis, and the significance level of the *t* value for gamma two.

For each tonal frequency, maximum, minimum, and 10th, 25th, 50th, 75th, and 90th percentiles of right, left, better ear, worse ear, and lateral differences.

Prevalence table of the scores from the otological inspection and general comments. separated by ear and by sex.

An output file of threshold and increment data for each examination.

AUDREAL -- This program operates on data from noise exposure questionnaires. It checks all input data for logical inconsistencies or errors and lists any invalid data by ID number and visit date. From user supplied specifications the program will calculate from either history or interval data, the following:

a separate noise score for each question according to assigned weightings,

total noise score, events score, gun score and chain saw score,

frequency distributions for each question score and for the total scores, and

an output file of all computed scores by individual. This file is used as input for other programs.

LPCOPY -- This program makes line printer copy of any output file from AUDREAL. The AUDREAL record is too large to use a conventional system utility command.

DISTAT2 -- This general purpose program computes descriptive statistics for any series of input variables. The statistics computed include: sample size, mean, standard deviation, gamma one measure of skewness, t value for gamma one, gamma two measure of kurtosis, and t value for gamma two, maximum, minimum, and 10th, 25th, 50th, 75th and 90th percentiles. These statistics can be computed for any age and sex category at the option of the user.

SAS -- This commercial program package is available at Wright State University. It is used to compute Spearman rank correlation coefficients for pairs of input variables for regression analyses and computation of residuals, and principle component analysis.

AUDOVER20 -- This program selects participants with auditory thresholds equal to or greater than +20 dB at each tonal frequency.

DREAM -- This general purpose program constructs serial event files.

AUDF34 -- This program calculates the proportions of participants exposed to specific noise-related events.

Other programs have been written to add the age at menarche and blood pressures of the high school group to the general Fels files and to extract from these files data relating to stature, blood pressure and skeletal age.

RESULTS AND DISCUSSION

DATA BASE

Since 12 August 1975, a total of 1278 audiometric examinations have been made. Because of initial equipment difficulties, the only auditory threshold data included in the present analyses are those obtained after 26 January 1976. Nevertheless, the noise exposure histories, interval questionnaires, health history and otological inspection results for the entire period are included. Since 26 January 1976, there have been 1110 examinations of 251 individuals, from 4 to 21 years of age.

Audiometric examinations are made six monthly, approximately on birthdays and "half-birthdays." Therefore, in the analyses, an age, for example, "6 years" refers to all those children measured on or about their sixth birthday (i.e., children between 5.75 and 6.24 years). The exact age distribution of examinations is given in Figure 1. Of the 1110 examinations, 567 were of males and 543 of females. It is clear from Figure 1 that the number of children in each age group is fairly uniform, except for the smaller numbers after 18 years and the larger numbers at 13 to 16 years. The latter is due to the addition of local school children to the Fels sample in this age range. The distribution of children at each age is rather evenly divided between the sexes.

The data subsequent to 26 January 1976 come from examinations on 205 Fels participants and 46 local school children. There are 31 individuals with one examination, 29 with two, 25 with three, 23 with four, 23 with five, 106 with six, and 14 with seven examinations. The children with more than one examination form the sample for analyses of 6-month increments in hearing levels.

TESTING CONTINUITY AND PARTICIPANT RESPONSES

Continuity and completeness of the auditory threshold testing procedure and the quality of participant responses were evaluated by the technician at each examination. The items regarding these aspects of the test and the appropriate definitions of the corresponding scores are included in the footnotes to Table 2. This table gives the prevalences of each of these scores for boys and girls of two age groups. The children represented in Table 2 comprise all children tested since August, 1975. Complete test data were obtained in about 92 percent of those aged 6-11 years and in about 97 percent of those aged 12-17 years. The percentages for whom the quality of responses was graded "good" varied from 68 to 75 percent within sex and age groups being almost the same in each sex and higher in the older groups.

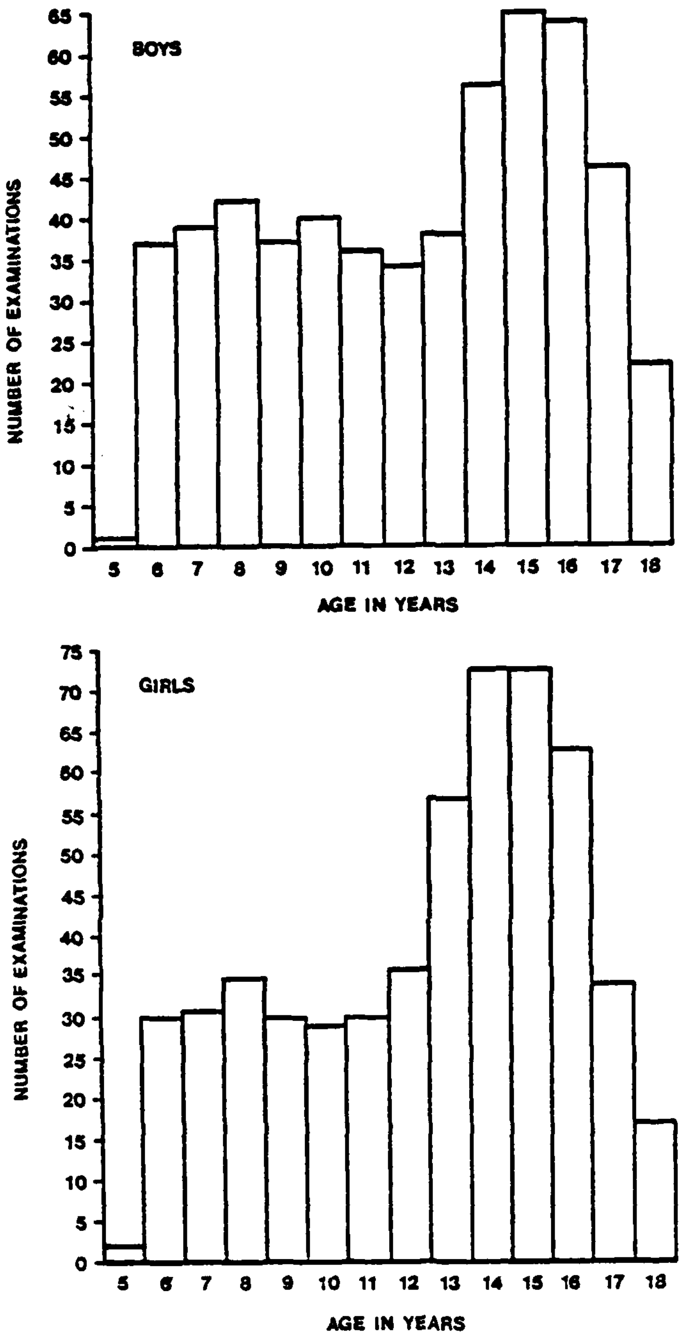

FIGURE 1 - NUMBER OF AUDIOMETRIC THRESHOLD EXAMINATIONS OF BOYS AND GIRLS AT EACH AGE

TABLE 2 - NUMBER OF EXAMINATIONS (AND PERCENTAGES) OF CHILDREN WITH SPECIFIC CHARACTERISTICS RATING THE CONTINUITY* AND QUALITY+ OF AUDITORY THRESHOLD TESTING

		BOYS				GIRLS			
		Continuity of Testing		Quality of Responses		Continuity of Testing		Quality of Responses	
Age Group	Rating Code	n	%	n	%	n	%	n	%
6-11 years									
	0	180	68	184	71	140	66	146	69
	1	40	15	5	2	39	18	15	7
	2	1	0	1	0	3	1	0	0
	3	4	2	8	3	6	3	5	2
	4	13	5	8	3	8	4	3	1
	5	6	2	1	0	1	0	0	0
	6	4	2	6	2	9	4	3	1
	7	6	2	0	0	3	1	0	0
	8	11	4	38	14	7	3	31	14
	9	0	0	14	5	0	0	13	6
Total		265		265		216		216	
12-17 years									
	0	303	87	254	75	332	90	283	73
	1	12	3	15	4	6	2	17	5
	2	6	2	0	0	7	1	2	1
	3	6	2	8	2	8	2	12	3
	4	6	2	1	0	7	1	2	1
	5	7	2	1	0	7	1	0	0
	6	0	0	15	4	0	0	19	5
	7	1	0	0	0	0	0	0	0
	8	6	2	53	15	10	3	40	11
	9	0	0	0	0	0	0	2	1
Total		347		347		377		377	

FOOTNOTES TO TABLE 2

* Continuity Ratings

0 = testing completed, no breaks
1 = testing completed, one short (<5 min) break between ears
2 = testing completed, one short (<5 min) break during testing of right ear
3 = testing completed, one short (<5 min) break during testing of left ear
4 = testing completed, took more than one break (see written comments)
5 = testing completed, certain frequencies retested (see written comments)
6 = testing discontinued, participant insisted (tired, restless, etc.)
7 = testing discontinued, responses too erratic (lack of cooperation, etc.)
8 = other--miscellaneous written comments

+ Response Ratings

0 = normal good responses or better
1 = often signaled when no tone played
2 = participant disinterested, not trying hard
3 = participant's responses seemed somewhat erratic
4 = participant very restless and "fidgety"
5 = participant talked frequently throughout test
6 = participant claimed to hear extraneous noises during test (see written comments)
7 = participant's parent in booth during testing
8 = other--miscellaneous written comments
9 = participant did well at the beginning but lost concentration toward end of test

Continuity - Sixty-eight percent of the younger boys completed the test without interruption (score = 0), while of the older boys 87 percent were able to complete the test without resting. The corresponding percentages for girls were 65 percent for younger girls, and 88 percent for older girls. A short interruption in the testing between ears (score = 1) for both sexes was much more common in the younger children than in the older children, although there was little evidence of a systematic age difference in the frequency of interruptions during the testing of a particular ear (scores 2 and 3). Multiple interruptions in the overall testing procedure (score = 4) were slightly more common in the younger children than in the older children.

There was little difference between the two age groups in the percentage of individuals who had to be retested at some frequency (score = 5). While 2 percent of the younger boys and 4 percent of the younger girls insisted that the test be discontinued (score = 6), none of the older children requested that the test be terminated. These findings are consistent with our earlier findings concerning a higher frequency of incomplete examinations in children younger than 6 years old.

Responses - There was little difference between the sexes in frequencies of good responses (score = 0), though good responses were more common among the older children than among the younger children. From 2 to 7 percent of the children gave false responses often (score = 1). This was about as common in older children as in younger children, and about as common in boys as girls. Erratic responses, talking, disinterest, and restlessness of participants (scores 2, 3, 4, 5, 9) were slightly more common in younger children.

OTOLOGICAL INSPECTIONS

Preceding the testing of auditory thresholds, an otological inspection was given each participant to record deviations from normality. In each category, a score of zero indicates a normal finding. The definitions of the findings indicated by each of the other scores of the otological inspection are given in Table 3. Tables 4 through 7 give the prevalence of each rating code for right and left ear of boys and girls 6 to 11 and 12 to 17 years old. The sample represented in these tables includes all children examined since testing commenced in August, 1975.

Tragus - There is little difference between age groups or sexes in the frequency of abnormal tragi, almost all being normal, and a maximum of 1 percent in any age group being considered "very large" (score = 1).

Meatus - The most frequent meatal abnormalities concerned obstructions of the external auditory canal. There seemed to be little sex or age difference for obstructed meati.

TABLE 3 - DEFINITION OF RATING CODES USED IN OTOLOGICAL EXAMINATIONS

Item	Code		Definition
Tragus			
	0	=	normal
	1	=	very large
	8	=	other--miscellaneous written comments
	9	=	no examination
Meatus			
	0	=	normal
	1	=	completely closed
	2	=	badly obstructed with wax, dirt, hair, almost closed
	3	=	very small or slit-like opening but unobstructed
	4	=	small opening badly obstructed with wax
	5	=	much wax, etc. in canal but not obstructed
	6	=	canal open but rather inflamed (very red) looking
	8	=	other--miscellaneous written comments
	9	=	no examination
Ear Drum			
	0	=	normal
	1	=	perforated
	2	=	not seen because meatus small or obstructed
	3	=	scarred
	8	=	other--miscellaneous written comments
	9	=	no examination
Ear Drum, Cone of Light			
	0	=	cone of light seen
	1	=	cone of light not seen (meatus too small or obstructed)
	2	=	cone of light not seen for other reasons
	8	=	other--miscellaneous written comments
	9	=	no examination
Ear Drum, Color			
	0	=	normal
	1	=	very red and inflamed looking
	2	=	dull
	3	=	yellowish
	4	=	redder than normal, but no inflamed looking
	8	=	other-- miscellaneous written comments
	9	=	no examination

TABLE 3 - DEFINITION OF RATING CODES USED IN OTOLOGICAL EXAMINATIONS (CONTINUED)

Item	Code		Definition
General Health at Time of Test			
	0	=	normal, not ill
	1	=	has "cold," but no ear problems
	2	=	is congested due to "sinus allergy"
	3	=	both ears "stopped up"
	4	=	right ear "stopped up"
	5	=	left ear "stopped up"
	6	=	has ear infection, but no earache
	7	=	has ear infection, with earache
	8	=	other--miscellaneous written comments
	9	=	not recorded

Tympanic Membrane - Only one child had a perforated ear drum when examined, and none had drum scars. The most common abnormalities are those dealing with the ability to see the cone of light reflected from the ear drum on otoscopic inspection. In about 20 percent of the inspections, the cone of light was not seen because of external auditory canal occlusion. In about 18 percent of the examinations, the cone of light was not seen for other reasons (code = 2); the rather high frequencies of this item may indicate inexperience of technicians, rather than ear pathology. Five to 8 percent of boys and girls had drums that were dull in appearance, lacking the luster typical of the normal tympanic membrane. There was little difference between the age groups. From 1 to 3 percent of the children inspected had ear drums that were red, suggesting some inflammation. The frequencies of additional comments (score = 8) indicates that many of the participants' conditions did not fit into any of the categories given.

THRESHOLDS

General Findings - Thresholds tend to decrease over time in children aged 6 to 17 years. The changes are summarized in Table 8, which presents, for each sex at each frequency in better and worse ears, the slopes of the linear regression of threshold on age. These slopes are smaller at higher frequencies in the boys. In both sexes, and in both ears, the tendency for a decrease in thresholds over age is present; in most cases, the slopes are significantly different from zero. There is also a tendency for the change with age to be smaller as the frequencies increase. The implication of these findings is that hearing improves during this age range. An alternative explanation is that the children's concentration and ability to perform the threshold examination improves with age, implying that thresholds measured in younger children are not their true thresholds.

TABLE 4 - PERCENTAGE OF EXAMINATIONS OF CHILDREN 6-11 YEARS OF AGE WITH SPECIFIC CODES ON OTOLOGICAL INSPECTION (LEFT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of Light	Color
Boys					
0	99	72	82	66	76
1	0	0	1	16	2
2	--	10	12	17	5
3	--	3	0	--	0
4	--	2	--	--	1
5	--	10	--	--	--
6	--	1	--	--	--
8	1	2	5	1	10
9	0	0	0	0	6
Girls					
0	100	64	74	60	65
1	0	2	0	22	1
2	--	12	17	16	5
3	--	5	0	--	0
4	--	2	--	--	3
5	--	10	--	--	--
6	--	3	--	--	--
8	0	2	8	2	18
9	0	0	1	0	8

[1]See Table 3 for code definitions.
Based on data from approximately 229 examinations in boys and 185 examinations in girls.

TABLE 5 - PERCENTAGE OF EXAMINATIONS OF CHILDREN 12-17 YEARS OF AGE WITH SPECIFIC CODE ON OTOLOGICAL INSPECTION (LEFT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of light	Color
Boys					
0	98	75	81	63	70
1	1	1	0	15	2
2	--	10	10	18	8
3	--	1	0	--	0
4	--	0	--	--	2
5	--	9	--	--	--
6	--	1	--	--	--
8	1	3	8	3	13
9	0	0	1	1	5
Girls					
0	100	77	84	61	77
1	0	2	0	19	1
2	--	8	10	18	6
3	--	1	0	--	0
4	--	0	--	--	0
5	--	8	--	--	--
6	--	1	--	--	--
8	0	3	5	2	11
9	0	0	1	0	5

[1] See Table 3 for code definitions.
Based on data from approximately 300 examinations in boys and 336 examinations in girls.

TABLE 6 - PERCENTAGE OF EXAMINATIONS OF CHILDREN 6-11 YEARS OF AGE WITH SPECIFIC CODES ON OTOLOGICAL INSPECTION (RIGHT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of Light	Color
Boys					
0	99	68	83	62	77
1	0	0	0	16	0
2	--	10	11	19	7
3	--	4	0	--	0
4	--	2	--	--	0
5	--	14	--	--	--
6	--	0	--	--	--
8	1	2	6	3	12
9	0	0	0	0	4
Girls					
0	100	64	79	58	74
1	0	0	0	23	1
2	--	15	15	17	5
3	--	3	0	--	0
4	--	3	--	--	1
5	--	12	--	--	--
6	--	1	--	--	--

[1]See Table 3 for code definitions.
Based on data from approximately 229 examinations in boys and 185 examinations in girls.

TABLE 7 -PERCENTAGE OF EXAMINATIONS OF CHILDREN 12-17 YEARS OF AGE WITH SPECIFIC CODES ON OTOLOGICAL INSPECTION (RIGHT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of light	Color
Boys					
0	98	72	84	59	78
1	1	1	0	19	0
2	--	10	10	20	5
3	--	1	0	--	0
4	--	0	--	--	2
5	--	11	--	--	--
6	--	2	--	--	--
8	1	3	6	2	10
9	0	0	0	0	5
Girls					
0	100	72	82	63	79
1	0	4	0	20	0
2	--	9	12	15	5
3	--	1	0	--	0
4	--	1	--	--	0
5	--	9	--	--	--
6	--	1	--	--	--
8	0	3	5	2	12
9	0	0	1	0	4

[1] See Table 3 for code definitions.
Based on data from approximately 300 examinations in boys and 336 examinations in girls.

TABLE 8 - SLOPE OF THE LINEAR REGRESSION OF AUDITORY THRESHOLD ON AGE IN BETTER OR WORSE EARS OF CHILDREN AGED 6 TO 17 YEARS

Frequency (Hz)	Better ear Slope (dB/year)	Worse Ear Slope
Boys		
500	-0.4 ± 0.1 **	-0.5 ± 0.1 **
1000	-0.3 ± 0.1 **	-0.4 ± 0.1 **
2000	-0.2 ± 0.1 *	-0.2 ± 0.1 *
4000	-0.1 ± 0.1	-0.1 ± 0.1
6000	-0.2 ± 0.1 *	-0.1 ± 0.1
Girls		
500	-0.7 ± 0.1 **	-0.8 ± 0.1 **
1000	-0.6 ± 0.1 **	-0.5 ± 0.1 **
2000	-0.6 ± 0.1 **	-0.5 ± 0.1 **
4000	-0.6 ± 0.1 **	-0.4 ± 0.1 **
6000	-0.5 ± 0.1 **	-0.4 ± 0.1 **

* $.01 < p \leq .05$

** $p \leq .01$

Threshold data at each annual age between 6 and 17 years are summarized in Tables 9 through 32. Each table presents, for a specific age and sex, the sample size, mean, standard deviation and quartiles for each frequency in right, left, better and worse ears and the right-left differences. In addition to standard frequencies, three derived variables are included. The difference between the two 1000 Hz tests (1st less 2nd) is designated "D1" and the difference between thresholds at 1000 Hz and 4000 Hz (1000 less 4000) is designated "D4." Finally, the mean threshold of those tested at 500 Hz, 1000 Hz and 2000 Hz, within an ear, is designated "M512."

The variation (standard deviation) about the mean threshold appears to be fairly constant across frequencies in a given ear (Tables 9-32); although there may be slightly more variation at the higher frequencies. The older children appear to show slightly less variation than the younger ones, with the exception of 17 year old males, who have unusually large standard deviations.

There is a very definite tendency, apparent at most every age, in each sex and ear, for thresholds to be higher at 4000 and 6000 Hz, than at 500, 1000 and 2000 Hz. Analysis of variance (randomized block design) indicated that significant differences among frequencies occurred at virtually every age. Duncan's multiple range tests indicated that there was a tendency for the 500, 1000 and 2000 Hz frequencies to have means not significantly different from each other; these threshold means tend to be smaller than those at 4000 and 6000 Hz. This effect was most pronounced in children aged 14 years and older. these findings are summarized in Table 33, where the overall mean auditory thresholds at each frequency are reported for right and left ears in boys and girls. In virtually every case, the ranking of means from largest to smallest is: 6000 Hz, 4000 Hz, 500 Hz, 1000 Hz, 2000 Hz.

Furthermore, there is a significanct Spearman rank correlation between age and auditory thresholds in each ear and sex at virtually every frequency (Table 34). The correlations are highly significant and all negative. There tend to be higher negative correlations with age at the lower frequencies. A negative correlation indicates that as the chidlren get older, their thresholds get lower; that is, their hearing improves. The negative correlations are somewhat larger in girls (-.2 to -.4), than in boys (-.1 to -.3).

Median thresholds are grouped across age for each frequency in better and worse ears in Figures 2 through 11. Each of these figures compares boys with girls. With a single exception, at each frequency, and in both the better and worse ears, there is a tendency for the median threshold at an age to be lower in girls, that is, the girls have better hearing. However, t-tests testing the significance of the sex differences between means at each frequency at each annual age revealed no significant differences. The tendency for females to have lower thresholds is least apparent at 4000 Hz.

TABLE 9 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	36	4.44	7.17	0.5	4.0	8.0
1000	37	3.84	8.30	0.0	4.0	10.0
2000	37	0.05	7.42	-6.0	0.0	6.0
4000	37	2.00	7.47	-4.0	2.0	7.0
6000	36	4.00	8.43	0.0	2.0	9.5
M512	36	3.00	6.25	0.0	2.5	9.0
D4	37	1.84	9.62	-4.0	0.0	6.0
D1	37	0.81	3.54	0.0	0.0	4.0
LEFT EAR						
500	30	5.13	9.03	0.0	3.0	8.5
1000	31	2.52	8.45	-4.0	0.0	8.0
2000	35	2.69	10.73	-4.0	2.0	8.0
4000	33	4.97	10.10	0.0	2.0	10.0
6000	31	6.06	8.37	0.0	8.0	12.0
M512	30	3.77	7.76	-1.2	1.0	6.5
D4	31	-1.87	8.99	-8.0	0.0	6.0
D1	31	0.32	3.83	-2.0	0.0	2.0
BETTER EAR						
500	37	2.00	6.72	-2.0	2.0	6.0
1000	37	0.65	6.90	-5.0	0.0	4.0
2000	37	-2.22	6.71	-8.0	-4.0	3.0
4000	37	-0.32	6.79	-4.0	0.0	2.0
6000	37	1.68	7.49	-2.0	0.0	7.0
M512	37	0.54	5.58	-4.0	1.0	4.0
D4	37	0.97	7.60	-4.0	0.0	5.0
WORSE EAR						
500	29	8.28	8.26	4.0	6.0	11.0
1000	31	6.32	8.95	0.0	4.0	14.0
2000	35	5.09	10.05	0.0	4.0	10.0
4000	33	7.58	9.15	3.0	6.0	12.0
6000	30	9.00	7.77	2.0	10.0	14.0
M512	29	6.97	7.30	1.5	5.0	12.0
D4	31	-0.84	10.20	-8.0	0.0	6.0
LEFT-RIGHT DIFFERENCES						
500	29	-0.41	9.20	-6.0	0.0	3.0
1000	31	-1.61	8.57	-6.0	-2.0	2.0
2000	35	2.51	11.29	-4.0	0.0	6.0
4000	33	2.97	11.72	-4.0	2.0	8.0
6000	30	1.67	9.35	-4.0	2.0	8.0
M512	29	0.52	6.98	-2.5	0.0	2.5

TABLE 10 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	27	3.33	7.06	0.0	2.0	6.0
1000	29	2.48	6.84	-1.0	2.0	6.0
2000	30	-0.13	5.96	-4.0	1.0	4.5
4000	29	3.79	6.15	0.0	4.0	9.0
6000	28	3.50	8.14	-2.0	4.0	7.5
M512	27	1.74	4.98	0.0	1.0	4.0
D4	28	-1.29	7.61	-6.0	-2.0	5.5
D1	29	0.41	2.69	-1.0	0.0	2.0
LEFT EAR						
500	21	3.14	8.73	-2.0	0.0	5.0
1000	23	-0.09	8.06	-6.0	0.0	4.0
2000	24	1.25	7.15	-2.0	1.0	5.5
4000	22	6.00	9.56	-0.5	6.0	12.0
6000	21	6.00	11.80	-3.0	6.0	13.0
M512	21	1.38	7.04	-2.0	0.0	2.5
D4	21	-6.38	8.55	-13.0	-6.0	0.0
D1	23	0.26	2.85	0.0	0.0	2.0
BETTER EAR						
500	27	1.41	5.89	-2.0	0.0	4.0
1000	29	-0.90	5.97	-6.0	0.0	4.0
2000	30	-1.53	5.70	-6.0	-2.0	2.5
4000	29	2.76	6.24	-1.0	4.0	7.0
6000	28	1.71	7.81	-3.5	2.0	6.0
M512	27	-0.15	4.38	-2.0	0.0	3.0
D4	28	-3.71	7.11	-7.5	-4.0	0.0
WORSE EAR						
500	21	5.62	9.24	0.0	2.0	9.0
1000	23	4.17	8.24	0.0	2.0	8.0
2000	24	3.00	6.65	0.0	3.0	6.0
4000	22	7.36	8.95	1.5	8.0	12.0
6000	21	8.38	11.11	-1.0	8.0	15.0
M512	21	3.95	7.05	0.0	3.0	5.5
D4	21	-4.10	7.99	-10.0	-6.0	4.0
LEFT-RIGHT DIFFERENCES						
500	21	0.38	7.92	-3.0	0.0	4.0
1000	23	-1.91	8.12	-8.0	-2.0	2.0
2000	24	1.25	6.43	-3.5	0.0	7.0
4000	22	2.09	5.77	-2.0	3.0	6.0
6000	21	3.05	10.89	-4.0	2.0	7.0
M512	21	0.48	5.21	-3.0	0.0	2.0

TABLE 11 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	3.57	8.51	-2.0	4.0	8.0
1000	37	2.97	9.16	-3.0	2.0	7.0
2000	38	-0.47	7.43	-6.0	0.0	4.5
4000	38	3.32	7.22	0.0	5.0	10.0
6000	38	3.00	8.34	-2.5	3.0	7.0
M512	37	2.43	6.91	-1.5	2.0	7.0
D4	37	-0.05	7.43	-6.0	0.0	4.0
D1	37	0.92	2.61	0.0	0.0	2.0
LEFT EAR						
500	37	1.03	7.16	-4.0	0.0	5.0
1000	38	0.95	8.35	-6.0	0.0	6.5
2000	38	-0.11	8.29	-6.0	-1.0	4.5
4000	38	3.00	7.49	-2.0	4.0	8.0
6000	37	3.89	9.79	-4.0	4.0	11.0
M512	37	1.00	6.40	-4.0	1.0	5.0
D4	38	-2.05	8.89	-10.0	-1.0	4.5
D1	38	0.05	3.62	-2.0	0.0	2.0
BETTER EAR						
500	38	0.16	7.36	-4.5	0.0	4.0
1000	38	-0.26	8.06	-8.0	0.0	6.0
2000	38	-2.68	7.07	-7.0	-4.0	2.0
4000	38	0.21	7.36	-4.5	0.0	6.0
6000	38	0.58	8.66	-6.5	0.0	4.5
M512	38	-0.39	6.31	-6.0	0.0	3.0
D4	38	-0.47	6.98	-6.0	0.0	4.5
WORSE EAR						
500	36	4.56	7.95	-2.0	4.0	9.5
1000	37	4.22	8.98	-2.0	4.0	8.0
2000	38	2.11	7.89	-4.0	1.0	6.5
4000	38	6.11	6.03	2.0	6.0	10.0
6000	37	6.38	8.55	2.0	6.0	11.0
M512	36	3.89	6.79	0.0	4.5	7.0
D4	37	-1.68	8.35	-8.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	36	-2.39*	6.50	-4.0	-2.0	1.5
1000	37	-1.68	6.17	-4.0	0.0	2.0
2000	38	0.37	6.32	-4.0	0.0	4.0
4000	38	-0.32	8.40	-4.0	0.0	4.0
6000	37	0.92	7.19	-5.0	0.0	6.0
M512	36	-0.61	4.31	-1.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 12 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	31	3.35	7.01	-2.0	2.0	8.0
1000	31	1.23	7.96	-4.0	0.0	6.0
2000	31	-0.26	6.30	-4.0	0.0	4.0
4000	31	3.68	8.81	-2.0	4.0	8.0
6000	31	2.32	8.92	-2.0	0.0	4.0
M512	31	1.97	5.94	-2.0	0.0	5.0
D4	31	-2.45	7.67	-8.0	-4.0	4.0
D1	31	1.48	3.93	0.0	2.0	4.0
LEFT EAR						
500	27	0.67	5.32	-2.0	0.0	4.0
1000	28	-0.43	5.64	-4.0	0.0	3.5
2000	28	0.71	4.88	-4.0	0.0	6.0
4000	28	0.50	6.75	-5.5	0.0	6.0
6000	28	0.50	7.46	-4.0	0.0	6.0
M512	27	0.78	3.91	-2.0	0.0	5.5
D4	28	-0.93	7.35	-6.0	-1.0	3.0
D1	28	0.50	2.22	0.0	0.0	2.0
BETTER EAR						
500	31	0.26	5.88	-2.0	0.0	2.0
1000	31	-1.10	6.34	-6.0	0.0	4.0
2000	31	-1.81	4.80	-4.0	-2.0	2.0
4000	31	-0.39	6.35	-6.0	0.0	4.0
6000	31	-0.52	6.71	-4.0	0.0	2.0
M512	31	-0.19	4.32	-3.0	0.0	2.0
D4	31	-0.71	7.67	-4.0	0.0	4.0
WORSE EAR						
500	27	4.22	6.36	0.0	4.0	8.0
1000	28	2.14	7.30	-3.5	0.0	6.0
2000	28	2.43	5.74	0.0	2.0	6.0
4000	28	5.00	8.75	-1.5	6.0	8.0
6000	28	3.64	9.29	-1.5	2.0	8.0
M512	27	3.19	5.53	0.0	2.0	7.5
D4	28	-2.86	6.96	-8.0	-4.0	1.5
LEFT-RIGHT DIFFERENCES						
500	27	-2.81*	5.64	-6.0	-2.0	0.0
1000	28	-1.50	5.41	-4.0	-1.0	1.5
2000	28	0.71	5.37	-2.0	0.0	4.0
4000	28	-3.71**	6.92	-6.0	-3.0	2.0
6000	28	-2.00	5.91	-6.0	0.0	0.0
M512	27	-0.70	4.08	-2.0	0.0	1.0

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 13 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	42	1.33	8.04	-4.0	1.0	6.0
1000	42	0.33	6.80	-4.0	0.0	4.0
2000	42	-0.24	7.98	-6.0	0.0	4.5
4000	42	1.71	6.56	-2.0	1.0	6.0
6000	42	2.62	9.09	-2.0	2.0	6.5
M512	42	0.93	5.68	-1.0	1.5	3.0
D4	42	-1.38	6.29	-4.0	-2.0	2.0
D1	42	1.38	2.81	0.0	0.0	2.5
LEFT EAR						
500	42	-0.29	7.98	-4.0	0.0	2.0
1000	42	0.29	6.21	-4.0	0.0	4.0
2000	42	-0.62	7.71	-6.5	2.0	4.0
4000	42	0.48	6.17	-4.0	0.0	6.0
6000	42	2.76	9.32	-2.5	4.0	8.5
M512	42	0.29	5.33	-3.3	0.5	3.0
D4	42	-0.19	6.87	-4.0	0.0	4.5
D1	42	0.52	3.25	0.0	0.0	2.0
BETTER EAR						
500	42	-1.33	7.41	-6.5	-2.0	2.0
1000	42	-1.62	6.53	-6.0	-2.0	2.0
2000	42	-2.95	7.65	-10.0	-5.0	2.5
4000	42	-1.14	5.96	-4.0	-2.0	2.5
6000	42	-0.14	7.53	-2.5	0.0	4.0
M512	42	-1.29	5.16	-6.0	0.0	1.2
D4	42	-0.48	5.58	-4.0	0.0	2.5
WORSE EAR						
500	42	2.38	8.23	-2.0	2.0	6.0
1000	42	2.24	5.88	-2.0	2.0	4.0
2000	42	2.10	7.18	-0.5	4.0	6.0
4000	42	3.33	6.00	0.0	4.0	8.0
6000	42	5.52	9.82	0.0	6.0	10.5
M512	42	2.50	5.42	0.0	3.0	5.0
D4	42	-1.10	6.69	-4.5	0.0	4.0
LEFT-RIGHT DIFFERENCES						
500	42	-1.62*	4.76	-4.5	-2.0	0.5
1000	42	-0.05	5.38	-2.0	0.0	4.0
2000	42	-0.38	6.96	-4.0	0.0	4.5
4000	42	-1.24	6.10	-6.0	0.0	2.0
6000	42	0.14	8.24	-4.0	0.0	6.0
M512	42	-0.17	3.39	-1.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 14 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	3.59	6.82	-0.5	5.0	8.0
1000	35	0.86	6.49	-4.0	0.0	6.0
2000	35	-1.31	7.45	-6.0	-2.0	2.0
4000	35	2.91	8.45	-4.0	4.0	8.0
6000	35	0.69	9.63	-8.0	0.0	6.0
M512	34	1.59	5.12	-1.0	1.0	5.5
D4	35	-2.06	9.26	-10.0	-2.0	4.0
D1	35	1.77	3.69	0.0	2.0	4.0
LEFT EAR						
500	34	0.18	7.29	-6.0	0.0	6.0
1000	34	-2.06	7.34	-8.5	-1.0	2.5
2000	34	-2.29	5.31	-4.5	-2.0	1.0
4000	34	-0.82	6.64	-6.0	0.0	4.0
6000	34	-0.65	8.75	-8.5	0.0	6.0
M512	34	-0.88	4.82	-4.0	0.0	1.2
D4	34	-1.24	8.50	-6.5	-2.0	2.0
D1	34	1.53	3.78	0.0	2.0	4.0
BETTER EAR						
500	34	-1.12	6.90	-7.0	0.0	4.0
1000	35	-2.51	6.92	-8.0	-4.0	2.0
2000	35	-4.29	4.63	-8.0	-4.0	-2.0
4000	35	-2.69	6.67	-8.0	-2.0	2.0
6000	35	-2.63	6.99	-10.0	-2.0	4.0
M512	34	-1.88	4.54	-5.3	-1.0	0.2
D4	35	0.17	8.19	-4.0	0.0	2.0
WORSE EAR						
500	34	4.88	6.29	0.0	6.0	10.0
1000	34	1.41	6.67	0.0	2.0	6.0
2000	34	0.76	7.10	-4.0	0.0	4.0
4000	34	4.94	6.98	0.0	5.0	10.0
6000	34	2.76	10.36	-8.0	4.0	8.5
M512	34	2.68	5.19	0.0	2.0	7.0
D4	34	-3.53	8.53	-10.0	-4.0	0.5
LEFT-RIGHT DIFFERENCES						
500	34	-3.41**	6.63	-8.0	-4.0	0.5
1000	34	-3.06**	4.60	-6.0	-2.0	0.0
2000	34	-1.12	7.41	-4.0	0.0	2.5
4000	34	-4.00*	9.07	-8.0	-5.0	2.0
6000	34	-1.47	7.82	-4.5	0.0	2.0
M512	34	-1.85**	3.81	-4.0	-2.0	0.2

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 15 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	1.84	9.62	-5.0	0.0	7.0
1000	37	0.97	8.39	-4.0	0.0	5.0
2000	37	0.92	8.12	-4.0	0.0	4.0
4000	37	1.73	6.53	-2.0	2.0	6.0
6000	37	2.05	8.08	-5.0	2.0	8.0
M512	37	1.62	6.53	-2.5	1.0	6.0
D4	37	-0.76	7.86	-5.0	-2.0	4.0
D1	37	1.03	2.77	0.0	0.0	2.0
LEFT EAR						
500	35	0.34	8.66	-4.0	0.0	4.0
1000	35	-0.23	8.23	-6.0	-2.0	6.0
2000	36	-1.06	8.19	-8.0	-2.0	4.0
4000	36	-0.67	6.22	-4.0	0.0	4.0
6000	35	3.94	10.05	-4.0	4.0	10.0
M512	35	0.26	6.53	-4.0	0.0	5.0
D4	35	0.40	6.56	-4.0	0.0	4.0
D1	35	0.57	3.35	0.0	0.0	2.0
BETTER EAR						
500	37	-0.65	8.47	-6.0	-2.0	2.0
1000	37	-1.68	7.67	-7.0	-2.0	4.0
2000	37	-1.95	7.82	-8.0	-4.0	2.0
4000	37	-1.89	5.60	-5.0	-2.0	2.0
6000	37	-0.16	8.37	-6.0	2.0	5.0
M512	37	-0.78	5.90	-4.5	-1.0	2.5
D4	37	0.22	7.08	-6.0	0.0	4.0
WORSE EAR						
500	35	2.97	9.55	-2.0	2.0	8.0
1000	35	2.57	8.44	-2.0	2.0	10.0
2000	36	1.89	8.14	-4.0	1.0	5.5
4000	36	3.06	6.37	0.0	4.0	8.0
6000	35	6.29	8.71	0.0	6.0	12.0
M512	35	2.91	6.88	-1.0	2.0	6.0
D4	35	-0.63	6.56	-4.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	35	-1.77*	4.70	-4.0	0.0	2.0
1000	35	-1.26	6.06	-8.0	0.0	2.0
2000	36	-1.94*	4.82	-4.0	-2.0	1.5
4000	36	-2.50*	6.26	-6.0	-2.0	1.5
6000	35	1.89	7.87	-4.0	2.0	8.0
M512	35	-1.11	3.40	-3.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 16 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	30	-0.33	5.71	-4.0	0.0	4.0
1000	30	-1.53	4.97	-6.0	-2.0	2.5
2000	30	-1.73	5.65	-6.0	-2.0	4.0
4000	30	0.93	7.44	-6.0	1.0	6.0
6000	30	1.87	8.07	-4.0	2.0	6.0
M512	30	-0.63	3.74	-3.0	0.0	2.3
D4	30	-2.47	8.18	-7.5	-2.0	2.5
D1	30	0.67	2.75	-2.0	0.0	2.0
LEFT EAR						
500	26	-0.69	5.93	-6.0	0.0	4.0
1000	28	-1.21	6.85	-6.0	-3.0	4.0
2000	29	-2.83	4.91	-6.0	-2.0	0.0
4000	28	0.29	5.52	-4.0	2.0	6.0
6000	28	0.93	7.84	-6.0	1.0	7.5
M512	26	-1.04	4.28	-4.3	0.0	1.5
D4	27	-1.85	7.36	-8.0	-2.0	2.0
D1	28	-0.43	2.90	-2.0	0.0	0.0
BETTER EAR						
500	30	-1.93	5.50	-6.0	-2.0	2.0
1000	30	-3.40	5.23	-6.5	-4.0	0.0
2000	30	-4.60	4.04	-8.0	-4.0	-2.0
4000	30	-1.40	5.54	-6.0	-2.0	4.0
6000	30	-0.73	7.47	-6.5	0.0	4.0
M512	30	-2.60	3.65	-4.0	-2.5	0.0
D4	30	-2.00	6.71	-6.5	-2.0	0.0
WORSE EAR						
500	26	1.15	5.72	-2.5	2.0	4.0
1000	28	0.79	5.90	-4.0	1.0	4.0
2000	29	0.14	5.40	-4.0	0.0	5.0
4000	28	2.79	6.91	0.0	3.0	6.0
6000	28	3.71	7.83	0.5	4.0	10.0
M512	26	1.12	4.14	-1.2	1.0	3.0
D4	27	-2.37	7.36	-6.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	26	-0.38	4.31	-4.0	0.0	2.5
1000	28	0.29	5.75	-4.0	0.0	5.0
2000	29	-1.10	6.36	-5.0	0.0	4.0
4000	28	-0.43	6.07	-4.0	0.0	4.0
6000	28	-0.71	6.72	-3.5	0.0	4.0
M512	26	0.23	3.01	-1.2	0.0	1.2

TABLE 17 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	40	2.35	7.80	-2.0	0.0	6.0
1000	40	0.25	7.31	-5.5	0.0	6.0
2000	40	1.15	6.56	-4.0	2.0	6.0
4000	40	2.50	6.84	-3.5	4.0	8.0
6000	40	1.55	6.48	-4.0	2.0	6.0
M512	40	1.63	5.12	-1.0	1.0	4.8
D4	40	-2.25	7.91	-6.0	-4.0	1.5
D1	40	1.90	2.60	0.0	2.0	4.0
LEFT EAR						
500	37	0.05	7.89	-5.0	0.0	4.0
1000	39	-0.67	6.98	-4.0	-2.0	2.0
2000	39	-1.23	6.35	-6.0	-2.0	4.0
4000	39	1.69	6.74	-4.0	0.0	8.0
6000	39	3.85	7.94	0.0	4.0	10.0
M512	37	0.08	5.41	-2.0	0.0	2.5
D4	39	-2.36	7.22	-6.0	-2.0	2.0
D1	39	0.36	3.37	-2.0	0.0	2.0
BETTER EAR						
500	40	-0.70	7.90	-4.0	-2.0	4.0
1000	40	-2.10	6.26	-6.0	-4.0	1.5
2000	40	-2.20	6.21	-6.0	-4.0	3.5
4000	40	-1.30	5.95	-4.0	-2.0	2.0
6000	40	-0.15	6.77	-6.0	0.0	4.0
M512	40	-1.02	4.85	-3.7	-1.0	0.7
D4	40	-0.80	6.93	-6.0	0.0	3.5
WORSE EAR						
500	37	3.35	7.39	0.0	0.0	6.0
1000	39	1.74	7.49	-4.0	0.0	8.0
2000	39	2.21	6.15	0.0	2.0	6.0
4000	39	5.59	5.72	2.0	6.0	10.0
6000	39	5.59	6.68	0.0	6.0	10.0
M512	37	2.86	5.47	0.0	2.0	6.0
D4	39	-3.85	6.87	-6.0	-6.0	0.0
LEFT-RIGHT DIFFERENCES						
500	37	-2.16*	5.38	-6.0	-2.0	2.0
1000	39	-0.92	4.98	-4.0	0.0	2.0
2000	39	-2.62**	4.92	-6.0	-2.0	0.0
4000	39	-0.87	8.72	-6.0	-2.0	6.0
6000	39	2.36	7.37	-2.0	2.0	8.0
M512	37	-1.32*	3.20	-3.0	0.0	0.5

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 18 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	29	-1.31	5.35	-6.0	0.0	2.0
1000	29	-1.03	5.55	-6.0	-2.0	4.0
2000	29	-0.28	6.41	-4.0	-2.0	2.0
4000	29	1.24	7.38	-4.0	0.0	6.0
6000	29	1.10	7.16	-4.0	2.0	5.0
M512	29	-0.31	3.87	-2.5	0.0	2.0
D4	29	-2.28	9.39	-6.0	0.0	4.0
D1	29	0.97	2.37	0.0	0.0	3.0
LEFT EAR						
500	29	-1.45	5.93	-4.0	-2.0	2.0
1000	29	-2.69	7.84	-10.0	-4.0	4.0
2000	29	-4.07	5.79	-8.0	-6.0	-1.0
4000	28	-0.36	7.66	-7.5	0.0	4.0
6000	29	-0.14	8.33	-7.0	-2.0	6.0
M512	29	-2.07	5.00	-6.0	-2.0	1.5
D4	28	-2.21	7.70	-6.0	-2.0	2.0
D1	29	1.38	3.71	0.0	0.0	4.0
BETTER EAR						
500	29	-3.72	5.36	-7.0	-4.0	0.0
1000	29	-4.90	5.89	-10.0	-6.0	1.0
2000	29	-5.10	4.80	-9.0	-6.0	-2.0
4000	29	-2.34	7.11	-10.0	-2.0	4.0
6000	29	-3.10	7.36	-10.0	-6.0	3.0
M512	29	-3.79	4.11	-7.0	-3.0	0.0
D4	29	-2.55	6.74	-6.0	-2.0	2.0
WORSE EAR						
500	29	0.97	4.86	-2.0	0.0	4.0
1000	29	1.17	6.31	-5.0	2.0	6.0
2000	29	0.76	6.42	-3.0	0.0	4.0
4000	28	3.36	6.84	-1.5	3.0	7.5
6000	29	4.07	6.38	-1.0	4.0	6.0
M512	29	1.41	4.32	-2.0	0.0	4.5
D4	28	-1.93	9.12	-6.0	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	29	-0.14	5.78	-5.0	-2.0	4.0
1000	29	-1.66	7.50	-7.0	-2.0	3.0
2000	29	-3.79**	6.01	-8.0	-4.0	0.0
4000	28	-2.07	6.52	-6.0	-2.0	2.0
6000	29	-1.24	9.26	-9.0	0.0	4.0
M512	29	-1.21	3.56	-4.0	-2.0	1.0

** $p \leq .01$

TABLE 19 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	35	0.06	6.92	-4.0	0.0	4.0
1000	36	-0.22	6.23	-4.0	0.0	4.0
2000	36	-2.17	6.00	-6.0	-2.0	0.0
4000	36	-0.22	6.10	-5.5	1.0	4.0
6000	36	0.56	8.49	-6.0	-2.0	6.0
M512	35	-0.46	4.80	-4.0	0.0	3.0
D4	36	0.00	5.89	-4.0	0.0	2.0
D1	36	1.72	2.79	0.0	2.0	4.0
LEFT EAR						
500	36	-0.39	6.60	-5.5	0.0	4.0
1000	36	-0.44	5.64	-6.0	-1.0	3.5
2000	36	-5.56	5.06	-10.0	-6.0	-2.0
4000	36	-2.00	6.91	-6.0	-2.0	3.5
6000	36	0.33	7.86	-6.0	1.0	6.0
M512	36	-1.50	4.25	-4.8	-1.0	1.8
D4	36	1.56	7.52	-4.0	2.0	6.0
D1	36	-0.17	1.99	-2.0	0.0	0.0
BETTER EAR						
500	36	-1.44	6.57	-6.0	-2.0	3.5
1000	36	-1.94	5.73	-6.0	-2.0	2.0
2000	36	-5.94	5.14	-11.5	-7.0	-2.0
4000	36	-3.22	5.96	-7.5	-3.0	1.5
6000	36	-2.67	7.19	-8.0	-4.0	2.0
M512	36	-2.44	4.37	-5.8	-2.0	0.0
D4	36	1.28	5.56	-2.0	0.0	4.0
WORSE EAR						
500	35	1.14	6.71	-4.0	2.0	4.0
1000	36	1.28	5.70	-3.5	2.0	4.0
2000	36	-1.78	5.67	-6.0	-1.0	0.0
4000	36	1.00	6.48	-4.0	2.0	6.0
6000	36	3.56	7.90	-2.0	4.0	8.0
M512	35	0.51	4.55	-2.0	1.0	3.0
D4	36	0.28	6.25	-3.5	0.0	3.5
LEFT-RIGHT DIFFERENCES						
500	35	-0.80	4.09	-2.0	0.0	2.0
1000	36	-0.22	4.16	-3.5	0.0	4.0
2000	36	-3.39**	5.17	-6.0	-2.0	0.0
4000	36	-1.78 *	5.12	-6.0	-2.0	1.5
6000	36	-0.22	8.79	-3.5	2.0	4.0
M512	35	-0.80	2.55	-2.0	0.0	1.0

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 20 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	30	-1.67	4.93	-6.0	-2.0	2.0
1000	30	-2.67	5.59	-6.5	-2.0	0.5
2000	30	-2.00	7.93	-6.5	-4.0	2.0
4000	30	0.60	7.54	-4.0	0.0	6.0
6000	30	0.33	8.12	-4.0	1.0	6.0
M512	30	-1.50	4.48	-4.3	-0.5	1.0
D4	30	-3.27	8.21	-10.0	-5.0	1.0
D1	30	1.07	3.05	0.0	2.0	2.0
LEFT EAR						
500	30	-1.27	5.79	-6.0	0.0	4.0
1000	30	-2.40	4.91	-6.5	-2.0	0.0
2000	30	-3.47	6.56	-10.0	-4.0	0.0
4000	30	1.00	9.21	-6.0	-1.0	8.0
6000	30	3.33	8.67	-2.0	2.0	10.5
M512	30	-1.77	4.30	-5.3	-1.0	1.0
D4	30	-3.40	8.92	-8.0	-2.0	2.0
D1	30	0.40	2.59	-2.0	0.0	2.0
BETTER EAR						
500	30	-2.80	5.19	-6.5	-2.0	2.0
1000	30	-3.80	4.68	-8.0	-3.0	0.0
2000	30	-5.20	5.29	-10.0	-5.0	-2.0
4000	30	-2.27	7.23	-6.0	-4.0	4.5
6000	30	-1.47	6.97	-7.0	-2.0	4.5
M512	30	-3.10	3.99	-6.0	-2.0	0.0
D4	30	-1.53	7.64	-6.5	-1.0	2.5
WORSE EAR						
500	30	-0.13	5.22	-4.5	1.0	4.0
1000	30	-1.27	5.50	-4.5	0.0	2.0
2000	30	-0.27	8.15	-6.0	-2.0	4.0
4000	30	3.87	8.37	-2.0	4.0	9.0
6000	30	5.13	8.64	0.0	4.0	12.5
M512	30	-0.10	4.84	-4.0	0.0	2.5
D4	30	-5.13	8.08	-10.0	-6.0	0.0
LEFT-RIGHT DIFFERENCES						
500	30	0.40	3.30	-2.0	0.0	2.5
1000	30	0.27	3.96	-2.0	0.0	2.0
2000	30	-1.47	7.50	-4.5	-1.0	2.0
4000	30	0.40	7.87	-6.0	0.0	6.0
6000	30	3.00*	8.03	-2.0	1.0	10.0
M512	30	0.20	2.11	-1.2	0.0	1.0

* $.01 < p \leq .05$

TABLE 21 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	-0.53	4.81	-4.0	-1.0	2.0
1000	34	-0.88	4.49	-4.0	0.0	2.0
2000	34	-1.29	4.37	-6.0	-1.0	2.0
4000	34	-0.06	5.49	-4.0	1.0	4.0
6000	34	0.35	6.56	-4.0	0.0	6.0
M512	34	-0.24	2.97	-1.0	0.0	1.0
D4	34	-0.82	6.72	-6.0	-2.0	2.5
D1	34	1.71	2.15	0.0	2.0	2.5
LEFT EAR						
500	33	-1.27	8.98	-6.0	-2.0	2.0
1000	33	-1.94	4.49	-4.0	-2.0	0.0
2000	33	-3.82	6.64	-9.0	-6.0	1.0
4000	33	-2.24	7.26	-9.0	-2.0	4.0
6000	33	-0.24	7.79	-5.0	0.0	5.0
M512	33	-1.55	5.54	-4.0	-2.0	0.0
D4	33	0.30	7.95	-6.0	2.0	6.0
D1	33	0.91	2.79	0.0	0.0	2.0
BETTER EAR						
500	34	-3.12	3.94	-6.0	-2.0	0.0
1000	34	-3.12	3.76	-6.0	-4.0	0.0
2000	34	-5.35	4.56	-8.5	-6.0	-2.0
4000	34	-3.59	6.28	-10.0	-3.0	2.0
6000	34	-1.94	6.54	-6.0	-2.0	2.5
M512	34	-2.88	3.14	-4.3	-2.0	-0.7
D4	34	0.47	6.89	-4.0	2.0	6.0
WORSE EAR						
500	33	1.39	8.84	-4.0	0.0	4.0
1000	33	0.36	4.54	-2.0	0.0	2.0
2000	33	0.36	5.35	-3.0	0.0	3.0
4000	33	1.39	5.71	-4.0	2.0	5.0
6000	33	2.12	7.24	-4.0	4.0	6.0
M512	33	1.12	5.04	0.0	0.0	2.0
D4	33	-1.03	6.84	-6.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	33	-0.73	9.26	-4.0	-2.0	0.0
1000	33	-1.21	4.55	-4.0	0.0	2.0
2000	33	-2.48	7.05	-8.0	-4.0	2.0
4000	33	-2.06	6.43	-4.0	-2.0	3.0
6000	33	-0.55	6.27	-5.0	0.0	2.0
M512	33	-0.88	5.14	-3.5	0.0	0.0

TABLE 22 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	35	-0.11	5.55	-4.0	0.0	4.0
1000	36	-0.56	6.00	-4.0	0.0	3.5
2000	36	-1.50	7.03	-7.5	-2.0	3.5
4000	36	-0.22	7.85	-6.0	0.0	4.0
6000	36	-0.44	8.09	-7.5	0.0	4.0
M512	35	-0.17	4.97	-2.0	0.0	1.0
D4	36	-0.33	7.41	-6.0	0.0	4.0
D1	36	0.67	3.41	0.0	0.0	2.0
LEFT EAR						
500	35	1.54	12.22	-6.0	-2.0	4.0
1000	35	1.54	13.98	-4.0	-2.0	4.0
2000	35	-2.17	10.93	-10.0	-6.0	6.0
4000	35	0.74	11.63	-10.0	2.0	6.0
6000	35	2.63	13.13	-12.0	2.0	10.0
M512	35	0.91	11.28	-4.0	-2.0	3.0
D4	35	0.80	10.12	-6.0	2.0	10.0
D1	35	1.31	6.40	-2.0	0.0	2.0
BETTER EAR						
500	35	-2.17	5.77	-6.0	-2.0	2.0
1000	36	-2.72	6.22	-4.0	-2.0	-2.0
2000	36	-4.89	6.77	-10.0	-7.0	0.0
4000	36	-3.33	7.04	-10.0	-4.0	2.0
6000	36	-2.89	8.45	-12.0	-3.0	4.0
M512	35	-2.66	4.94	-5.0	-3.0	0.0
D4	36	0.61	7.10	-4.0	2.0	5.5
WORSE EAR						
500	35	3.60	11.46	-2.0	2.0	6.0
1000	35	3.77	13.16	-2.0	0.0	4.0
2000	35	1.31	10.16	-6.0	0.0	8.0
4000	35	3.94	10.98	-4.0	4.0	10.0
6000	35	5.14	11.73	0.0	4.0	10.0
M512	35	3.43	10.63	-1.0	0.0	4.0
D4	35	-0.17	9.58	-6.0	0.0	8.0
LEFT-RIGHT DIFFERENCES						
500	35	1.66	11.09	-4.0	0.0	2.0
1000	35	2.06	13.27	-4.0	0.0	2.0
2000	35	-0.51	10.26	-6.0	-2.0	2.0
4000	35	0.86	11.61	-6.0	0.0	4.0
6000	35	2.91	10.13	-4.0	2.0	8.0
M512	35	1.77	10.21	-4.0	0.0	1.0

TABLE 23 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	38	-2.58	5.62	-6.0	-2.0	2.0
1000	38	-2.79	3.93	-4.5	-2.0	0.0
2000	38	-4.21	6.25	-10.0	-5.0	0.0
4000	38	-2.58	7.20	-8.5	-3.0	2.0
6000	38	-2.16	8.32	-12.0	-1.0	4.5
M512	38	-2.39	3.67	-5.0	-2.0	0.0
D4	38	-0.21	7.08	-4.0	0.0	4.0
D1	38	1.05	2.22	0.0	0.0	2.0
LEFT EAR						
500	37	-3.19	5.78	-8.0	-4.0	2.0
1000	37	-3.68	5.36	-7.0	-4.0	0.0
2000	38	-5.21	6.21	-10.0	-6.0	-1.5
4000	38	-2.74	7.06	-10.0	-2.0	4.0
6000	38	-2.58	7.31	-10.0	-3.0	4.0
M512	37	-3.27	4.61	-7.0	-3.0	0.0
D4	37	-0.65	6.58	-5.0	0.0	4.0
D1	37	0.92	2.85	0.0	0.0	2.0
BETTER EAR						
500	38	-4.16	5.33	-8.5	-4.0	0.0
1000	38	-4.84	4.64	-10.0	-4.0	-2.0
2000	38	-6.32	5.78	-10.5	-6.0	-4.0
4000	38	-5.16	6.06	-12.0	-6.0	0.0
6000	38	-5.16	6.98	-12.0	-8.0	0.0
M512	38	-4.29	4.13	-8.0	-4.0	-0.7
D4	38	0.32	5.31	-4.0	0.0	2.5
WORSE EAR						
500	37	-1.57	5.78	-6.0	0.0	3.0
1000	37	-1.57	4.17	-4.0	-2.0	0.0
2000	38	-3.11	6.29	-8.0	-4.0	2.0
4000	38	-0.16	7.22	-6.5	1.0	4.0
6000	38	0.42	7.61	-6.5	2.0	6.0
M512	37	-1.38	3.97	-4.0	-1.0	1.0
D4	37	-1.19	7.42	-6.0	-2.0	5.0
LEFT-RIGHT DIFFERENCES						
500	37	-0.59	3.68	-2.0	0.0	2.0
1000	37	-0.86	4.44	-4.0	0.0	3.0
2000	38	-1.00	4.96	-2.0	0.0	2.0
4000	38	-0.16	6.70	-4.0	0.0	4.0
6000	38	-0.42	7.41	-6.0	0.0	2.5
M512	37	-0.35	2.49	-1.5	0.0	1.0

TABLE 24 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	57	-0.25	7.13	-5.0	0.0	4.0
1000	57	-1.40	7.02	-6.0	-2.0	2.0
2000	57	-3.40	6.67	-9.0	-4.0	0.0
4000	57	-0.77	7.59	-6.0	0.0	4.0
6000	57	0.07	9.17	-6.0	0.0	4.0
M512	57	-1.04	5.42	-4.5	-1.0	1.0
D4	57	-0.63	6.73	-6.0	0.0	4.0
D1	57	0.91	3.25	0.0	2.0	3.0
LEFT EAR						
500	57	-1.65	8.82	-8.0	-4.0	3.0
1000	57	-2.11	11.27	-9.0	-6.0	0.0
2000	56	-2.64	11.10	-10.0	-6.0	0.0
4000	57	0.28	11.29	-9.0	0.0	6.0
6000	57	-0.67	9.79	-10.0	-2.0	6.0
M512	56	-1.27	9.16	-6.8	-4.0	0.0
D4	57	-2.39	6.55	-6.0	-2.0	2.0
D1	57	0.07	3.32	-2.0	0.0	2.0
BETTER EAR						
500	57	-3.30	7.04	-8.0	-4.0	0.0
1000	57	-5.05	5.88	-10.0	-6.0	-4.0
2000	57	-5.93	6.09	-12.0	-8.0	-3.0
4000	57	-3.44	6.78	-10.0	-4.0	1.0
6000	57	-3.68	8.36	-11.0	-6.0	0.0
M512	57	-3.91	5.15	-7.0	-6.0	-1.5
D4	57	-1.61	5.59	-6.0	-2.0	2.0
WORSE EAR						
500	57	1.40	8.31	-4.0	0.0	4.0
1000	57	1.54	10.95	-6.0	0.0	5.0
2000	56	-0.07	10.64	-6.0	-2.0	2.0
4000	57	2.95	10.90	-4.0	2.0	8.0
6000	57	3.09	9.34	-4.0	4.0	8.0
M512	56	1.48	8.74	-3.7	0.0	2.8
D4	57	-1.40	6.97	-5.0	-2.0	3.0
LEFT-RIGHT DIFFERENCES						
500	57	-1.40	6.07	-6.0	-2.0	2.0
1000	57	-0.70	11.02	-6.0	-4.0	2.0
2000	56	0.96	11.13	-4.0	0.0	2.0
4000	57	1.05	10.30	-6.0	0.0	3.0
6000	57	-0.74	9.12	-6.0	0.0	5.0
M512	56	0.30	7.89	-3.0	-1.0	0.0

TABLE 25 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	56	-1.96	6.10	-6.0	-2.0	2.0
1000	56	-3.07	4.79	-6.0	-4.0	0.0
2000	56	-2.79	6.62	-8.0	-4.0	2.0
4000	56	-0.39	7.38	-6.0	0.0	6.0
6000	56	-1.04	7.54	-6.0	-2.0	4.0
M512	56	-1.91	4.11	-5.0	-2.0	0.7
D4	56	-2.68	8.16	-8.0	-4.0	2.0
D1	56	1.11	3.28	0.0	0.0	2.0
LEFT EAR						
500	56	-3.04	5.95	-8.0	-4.0	0.0
1000	56	-4.61	5.69	-10.0	-6.0	0.0
2000	56	-2.96	6.67	-8.0	-4.0	0.0
4000	56	-0.32	7.00	-5.5	0.0	5.5
6000	56	-0.32	8.32	-8.0	0.0	6.0
M512	56	-2.80	4.68	-7.0	-3.5	0.7
D4	56	-4.29	7.25	-10.0	-4.0	0.0
D1	56	0.32	1.82	0.0	0.0	2.0
BETTER EAR						
500	56	-4.21	5.85	-8.0	-6.0	0.0
1000	56	-5.43	5.21	-10.0	-6.0	-0.5
2000	56	-4.79	5.90	-10.0	-6.0	0.0
4000	56	-2.50	6.61	-7.5	-3.0	2.0
6000	56	-3.46	7.00	-10.0	-4.0	1.5
M512	56	-3.95	4.30	-8.0	-4.0	-1.0
D4	56	-2.93	7.06	-8.0	-4.0	0.0
WORSE EAR						
500	56	-0.79	5.73	-6.0	-1.0	2.0
1000	56	-2.25	4.93	-6.0	-2.0	2.0
2000	56	-0.96	6.79	-6.0	-2.0	4.0
4000	56	1.79	7.10	-2.0	4.0	6.0
6000	56	2.11	7.85	-4.0	4.0	8.0
M512	56	-0.71	4.31	-4.0	-1.0	3.0
D4	56	-4.04	7.56	-10.0	-5.0	0.0
LEFT-RIGHT DIFFERENCES						
500	56	-1.07	4.58	-4.0	0.0	2.0
1000	56	-1.54 **	3.98	-4.0	-2.0	1.5
2000	56	-0.18	5.34	-2.0	0.0	2.0
4000	56	0.07	5.73	-4.0	0.0	4.0
6000	56	0.71	7.23	-4.0	0.0	6.0
M512	56	-0.39	2.40	-2.0	0.0	1.0

** $p \leq .01$

TABLE 26 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	73	-2.19	6.11	-6.0	-2.0	0.0
1000	73	-3.45	5.68	-6.0	-4.0	0.0
2000	73	-3.95	6.00	-10.0	-6.0	0.0
4000	73	-1.07	6.47	-4.0	0.0	4.0
6000	73	-0.52	8.45	-6.0	-2.0	4.0
M512	73	-2.42	4.54	-6.0	-2.0	0.5
D4	73	-2.38	6.41	-6.0	-2.0	2.0
D1	73	1.67	3.04	0.0	2.0	4.0
LEFT EAR						
500	73	-2.79	6.32	-8.0	-4.0	2.0
1000	73	-3.56	10.52	-8.0	-6.0	-1.0
2000	73	-4.49	9.31	-10.0	-6.0	-4.0
4000	73	-0.14	11.19	-6.0	-2.0	4.0
6000	73	-1.05	8.46	-8.0	-2.0	4.0
M512	73	-2.79	7.40	-6.5	-5.0	0.0
D4	73	-3.42	8.50	-7.0	-2.0	2.0
D1	73	0.08	2.82	-2.0	0.0	2.0
BETTER EAR						
500	73	-4.19	5.75	-8.0	-4.0	0.0
1000	73	-6.16	4.59	-10.0	-6.0	-4.0
2000	73	-6.82	5.05	-10.0	-8.0	-5.0
4000	73	-3.78	6.11	-10.0	-4.0	0.0
6000	73	-3.53	7.37	-10.0	-6.0	2.0
M512	73	-4.82	4.09	-8.0	-5.0	-2.0
D4	73	-2.38	5.39	-6.0	-2.0	0.0
WORSE EAR						
500	73	-0.79	6.22	-6.0	-2.0	4.0
1000	73	-0.85	10.37	-6.0	-4.0	2.0
2000	73	-1.62	9.14	-6.0	-4.0	1.0
4000	73	2.58	10.48	-4.0	0.0	6.0
6000	73	1.96	8.58	-4.0	2.0	8.0
M512	73	-0.44	7.15	-5.0	-1.0	1.0
D4	73	-3.42	8.31	-6.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	73	-0.60	4.46	-4.0	-2.0	2.0
1000	73	-0.11	11.11	-4.0	-2.0	0.0
2000	73	-0.55	9.00	-4.0	-2.0	0.0
4000	73	0.93	10.89	-4.0	0.0	4.0
6000	73	-0.53	7.33	-6.0	0.0	4.0
M512	73	0.22	7.06	-2.0	-1.0	1.0

TABLE 27 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	65	-2.46	6.10	-6.0	-4.0	1.0
1000	65	-2.46	5.86	-6.0	-2.0	1.0
2000	65	-2.98	6.40	-8.0	-2.0	1.0
4000	65	0.52	7.56	-4.0	2.0	5.0
6000	65	-1.11	9.58	-8.0	-2.0	4.0
M512	65	-1.91	4.46	-5.0	-2.0	0.0
D4	65	-2.98	6.41	-8.0	-4.0	2.0
D1	65	0.83	3.39	0.0	0.0	2.0
LEFT EAR						
500	65	-3.26	5.87	-7.0	-4.0	0.0
1000	65	-2.89	6.22	-6.0	-4.0	0.0
2000	65	-2.80	7.25	-8.0	-4.0	0.0
4000	65	0.25	7.80	-4.0	0.0	4.0
6000	65	-0.22	9.27	-9.0	0.0	7.0
M512	65	-2.17	4.67	-4.5	-2.0	-0.5
D4	65	-3.14	9.09	-10.0	-4.0	2.0
D1	65	0.12	2.57	-2.0	0.0	2.0
BETTER EAR						
500	65	-5.02	5.34	-10.0	-4.0	-1.0
1000	65	-5.08	5.12	-10.0	-4.0	-2.0
2000	65	-5.60	5.64	-10.0	-6.0	-2.0
4000	65	-1.88	7.40	-9.0	-2.0	2.0
6000	65	-3.54	7.92	-11.0	-4.0	2.0
M512	65	-4.38	4.04	-7.0	-5.0	-2.0
D4	65	-3.20	7.11	-9.0	-4.0	1.0
WORSE EAR						
500	65	-0.71	5.84	-4.0	0.0	2.0
1000	65	-0.28	5.93	-4.0	0.0	2.0
2000	65	-0.18	6.85	-4.0	0.0	2.0
4000	65	2.65	7.27	-2.0	4.0	6.0
6000	65	2.22	9.93	-6.0	0.0	8.0
M512	65	0.25	4.57	-2.0	0.0	2.0
D4	65	-2.92	7.89	-8.0	-4.0	4.0
LEFT-RIGHT DIFFERENCES						
500	65	-0.80	5.54	-4.0	0.0	4.0
1000	65	-0.43	6.28	-4.0	-2.0	2.0
2000	65	0.18	7.96	-4.0	0.0	4.0
4000	65	-0.28	6.21	-4.0	0.0	4.0
6000	65	0.89	7.67	-3.0	0.0	6.0
M512	65	0.23	3.79	-2.0	0.0	2.5

TABLE 28 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	73	-3.70	6.02	-8.0	-4.0	0.0
1000	73	-3.78	5.73	-8.0	-4.0	0.0
2000	73	-4.41	5.63	-8.0	-6.0	0.0
4000	73	-1.90	6.69	-6.0	-2.0	2.0
6000	73	-1.81	8.46	-10.0	-2.0	4.0
M512	73	-3.15	4.48	-6.0	-4.0	0.0
D4	73	-1.88	6.62	-8.0	0.0	2.0
D1	73	1.04	2.61	0.0	0.0	2.0
LEFT EAR						
500	73	-4.63	6.23	-10.0	-6.0	-2.0
1000	73	-3.75	10.58	-10.0	-6.0	-2.0
2000	73	-3.64	10.02	-10.0	-6.0	-2.0
4000	73	-0.79	10.57	-10.0	-2.0	6.0
6000	73	-1.32	8.29	-9.0	0.0	4.0
M512	73	-3.21	7.59	-8.0	-4.0	-1.0
D4	73	-2.96	7.82	-8.0	-2.0	2.0
D1	73	0.36	2.55	0.0	0.0	2.0
BETTER EAR						
500	73	-6.03	5.24	-12.0	-6.0	-2.0
1000	73	-6.77	4.55	-12.0	-6.0	-4.0
2000	73	-6.66	4.91	-10.0	-8.0	-4.0
4000	73	-4.45	6.16	-12.0	-4.0	0.0
6000	73	-3.92	7.11	-12.0	-4.0	0.0
M512	73	-5.53	4.14	-9.0	-6.0	-3.0
D4	73	-2.32	5.41	-6.0	-2.0	0.0
WORSE EAR						
500	73	-2.30	6.39	-6.0	-4.0	2.0
1000	73	-0.77	10.28	-6.0	-2.0	0.0
2000	73	-1.40	9.71	-6.0	-4.0	1.0
4000	73	1.75	9.98	-5.0	2.0	6.0
6000	73	0.79	8.86	-5.0	2.0	5.0
M512	73	-0.81	7.23	-5.0	-2.0	0.5
D4	73	-2.52	7.43	-8.0	-2.0	2.0
LEFT-RIGHT DIFFERENCES						
500	73	-0.93	4.73	-4.0	-2.0	2.0
1000	73	0.03	11.27	-4.0	0.0	2.0
2000	73	0.77	9.82	-4.0	0.0	4.0
4000	73	1.11	9.74	-5.0	0.0	6.0
6000	73	0.49	6.50	-3.0	0.0	4.0
M512	73	0.60	7.13	-2.0	0.0	1.0

TABLE 29 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	64	-1.72	5.41	-6.0	-2.0	2.0
1000	64	-2.31	5.32	-6.0	-4.0	2.0
2000	64	-1.53	5.91	-6.0	-1.0	4.0
4000	64	1.13	7.62	-4.0	2.0	6.0
6000	64	1.75	7.74	-4.0	0.0	6.0
M512	64	-1.22	4.17	-4.0	0.0	1.0
D4	64	-3.44	7.19	-8.0	-4.0	0.0
D1	64	0.87	2.76	0.0	0.0	2.0
LEFT EAR						
500	64	-3.69	6.04	-8.0	-4.0	1.5
1000	64	-3.03	6.17	-8.0	-2.0	0.0
2000	64	-1.75	7.25	-7.5	-4.0	4.0
4000	64	1.94	7.87	-4.0	2.0	6.0
6000	64	1.97	9.49	-5.5	3.0	8.0
M512	64	-2.14	4.97	-6.0	-2.0	1.0
D4	64	-4.97	8.08	-10.0	-6.0	1.5
D1	64	0.62	2.78	-1.5	0.0	2.0
BETTER EAR						
500	64	-4.63	5.06	-8.0	-5.0	-2.0
1000	64	-4.34	5.40	-10.0	-4.0	0.0
2000	64	-3.94	5.78	-8.0	-6.0	0.0
4000	64	-1.50	7.02	-6.0	0.0	2.0
6000	64	-1.31	7.79	-8.0	0.0	4.0
M512	64	-3.50	4.21	-6.8	-4.0	0.0
D4	64	-2.84	7.32	-6.0	-2.0	0.0
WORSE EAR						
500	64	-0.78	5.88	-5.5	-2.0	2.0
1000	64	-1.00	5.65	-5.5	0.0	4.0
2000	64	0.66	6.59	-4.0	2.0	6.0
4000	64	4.56	7.24	0.0	5.0	8.0
6000	64	5.03	8.29	0.0	6.0	9.5
M512	64	0.16	4.63	-3.0	0.0	2.8
D4	64	-5.56	7.01	-10.0	-6.0	-2.0
LEFT-RIGHT DIFFERENCES						
500	64	-1.97 **	4.68	-5.5	-2.0	1.5
1000	64	-0.72	4.18	-4.0	-1.0	2.0
2000	64	-0.22	5.87	-4.0	0.0	4.0
4000	64	0.81	7.50	-4.0	0.0	6.0
6000	64	0.22	8.02	-5.5	2.0	5.5
M512	64	-0.52	2.88	-2.0	0.0	1.0

** $p \leq .01$

TABLE 30 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	63	-4.03	6.39	-8.0	-4.0	0.0
1000	63	-4.22	6.02	-8.0	-4.0	0.0
2000	63	-4.70	6.15	-10.0	-6.0	0.0
4000	63	-2.06	6.75	-8.0	-2.0	4.0
6000	63	-3.11	7.92	-10.0	-6.0	2.0
M512	63	-3.48	5.03	-7.0	-4.0	0.0
D4	63	-2.16	7.19	-8.0	-2.0	4.0
D1	63	1.21	3.36	0.0	0.0	4.0
LEFT EAR						
500	63	-5.43	5.67	-10.0	-6.0	-2.0
1000	63	-6.29	4.71	-10.0	-8.0	-4.0
2000	63	-6.16	5.22	-12.0	-6.0	-4.0
4000	63	-1.05	9.97	-8.0	-2.0	2.0
6000	63	-1.52	8.70	-10.0	0.0	4.0
M512	63	-5.05	4.30	-9.0	-5.0	-2.0
D4	63	-5.24	9.48	-10.0	-4.0	0.0
D1	63	0.51	2.85	0.0	0.0	2.0
BETTER EAR						
500	63	-6.95	4.43	-12.0	-6.0	-2.0
1000	63	-7.43	3.84	-12.0	-8.0	-4.0
2000	63	-7.84	4.02	-12.0	-8.0	-4.0
4000	63	-4.95	5.81	-10.0	-4.0	0.0
6000	63	-5.43	6.48	-12.0	-8.0	0.0
M512	63	-6.43	3.39	-10.0	-6.0	-4.0
D4	63	-2.48	5.20	-6.0	-2.0	0.0
WORSE EAR						
500	63	-2.51	6.66	-8.0	-2.0	0.0
1000	63	-3.08	6.02	-6.0	-4.0	0.0
2000	63	-3.02	6.18	-8.0	-4.0	2.0
4000	63	1.84	9.39	-4.0	2.0	4.0
6000	63	0.79	8.83	-6.0	0.0	8.0
M512	63	-2.08	5.12	-6.0	-2.0	0.0
D4	63	-4.92	9.85	-10.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	63	-1.40	6.87	-4.0	-2.0	2.0
1000	63	-2.06*	6.24	-4.0	-2.0	2.0
2000	63	-1.46	7.23	-4.0	0.0	2.0
4000	63	1.02	11.48	-4.0	-2.0	2.0
6000	63	1.59	8.32	-2.0	0.0	8.0
M512	63	-0.94	5.45	-2.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 31 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF BOYS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	46	-0.91	12.83	-6.5	-2.0	2.0
1000	46	-1.78	13.02	-6.0	-4.0	0.0
2000	46	-2.04	12.65	-8.5	-4.0	0.0
4000	46	1.43	15.25	-4.5	0.0	6.0
6000	46	2.61	16.03	-8.0	1.0	10.0
M512	46	-0.87	12.11	-6.0	-2.0	1.0
D4	46	-3.22	7.86	-8.0	-3.0	2.0
D1	46	1.78	3.02	0.0	0.0	4.0
LEFT EAR						
500	46	-2.96	13.08	-8.0	-4.0	0.0
1000	46	-1.70	13.45	-6.5	-3.0	0.0
2000	46	-2.00	14.03	-12.0	-5.0	2.5
4000	46	1.70	14.92	-6.0	0.0	6.0
6000	46	2.43	16.44	-10.0	-1.0	6.5
M512	46	-1.41	12.77	-7.0	-3.0	0.0
D4	46	-3.39	6.66	-6.5	-2.0	2.0
D1	46	-0.22	2.77	-2.0	0.0	2.0
BETTER EAR						
500	46	-4.17	12.89	-10.0	-6.0	-2.0
1000	46	-3.35	13.13	-8.5	-6.0	-2.0
2000	46	-4.65	12.99	-12.0	-7.0	-2.0
4000	46	-1.30	14.66	-10.0	-4.0	2.0
6000	46	-0.91	14.65	-12.0	-4.0	2.5
M512	46	-3.20	12.41	-8.0	-6.0	-2.0
D4	46	-2.04	6.36	-8.0	0.0	0.5
WORSE EAR						
500	46	0.30	12.70	-4.5	-2.0	2.0
1000	46	-0.13	13.15	-4.5	-2.0	2.0
2000	46	0.61	13.19	-6.0	-2.0	4.0
4000	46	4.43	14.94	-2.0	2.0	8.0
6000	46	5.96	16.99	-4.5	4.0	10.0
M512	46	0.93	12.32	-3.3	0.0	2.0
D4	46	-4.57	6.47	-10.0	-4.0	0.0
LEFT-RIGHT DIFFERENCES						
500	46	-2.04*	5.29	-6.0	-2.0	2.0
1000	46	0.09	4.38	-4.0	0.0	2.0
2000	46	0.04	6.81	-4.0	0.0	4.0
4000	46	0.26	7.50	-4.5	0.0	4.0
6000	46	-0.17	9.41	-6.0	0.0	4.5
M512	46	-0.09	3.12	-2.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 32 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	-4.59	7.78	-10.0	-6.0	-2.0
1000	34	-3.94	9.14	-12.0	-4.0	-2.0
2000	34	-4.35	6.54	-10.0	-6.0	-1.5
4000	34	-4.35	6.83	-12.0	-5.0	0.5
6000	34	-1.12	10.68	-10.5	-4.0	4.5
M512	34	-3.44	7.05	-8.3	-4.0	-1.8
D4	34	0.41	9.54	-6.0	0.0	4.0
D1	34	0.59	3.06	0.0	0.0	2.0
LEFT EAR						
500	34	-5.76	6.26	-12.0	-8.0	0.0
1000	34	-5.88	4.43	-10.0	-5.0	-2.0
2000	34	-5.71	6.84	-10.5	-7.0	-2.0
4000	34	0.12	10.35	-7.0	0.0	6.0
6000	34	0.29	8.49	-10.0	1.0	6.0
M512	34	-4.94	4.66	-10.0	-5.5	-1.0
D4	34	-6.00	9.12	-10.0	-4.0	0.0
D1	34	0.53	1.99	0.0	0.0	2.0
BETTER EAR						
500	34	-7.35	5.32	-12.0	-10.0	-5.5
1000	34	-7.29	4.06	-12.0	-6.0	-4.0
2000	34	-7.71	3.91	-12.0	-8.0	-4.0
4000	34	-5.76	5.82	-12.0	-6.0	0.0
6000	34	-4.18	7.34	-12.0	-4.0	2.0
M512	34	-6.47	3.80	-10.0	-7.0	-3.0
D4	34	-1.53	4.75	-4.0	0.0	0.0
WORSE EAR						
500	34	-3.00	7.90	-8.0	-4.0	0.5
1000	34	-2.53	8.77	-7.0	-4.0	-1.5
2000	34	-2.35	7.78	-8.0	-5.0	2.0
4000	34	1.53	10.14	-4.5	2.0	6.0
6000	34	3.35	10.19	-4.5	5.0	10.5
M512	34	-1.91	6.95	-5.3	-2.0	0.0
D4	34	-4.06	11.33	-8.5	-3.0	0.0
LEFT-RIGHT DIFFERENCES						
500	34	-1.18	7.02	-2.5	0.0	2.0
1000	34	-1.94	9.58	-2.5	0.0	2.0
2000	34	-1.35	8.37	-4.5	-2.0	0.0
4000	34	4.47*	10.92	0.0	2.0	8.5
6000	34	1.41	10.85	-2.0	0.0	8.0
M512	34	-1.03	7.07	-1.2	0.0	1.0

* $.01 < p \leq .05$

TABLE 33 - MEAN AUDITORY THRESHOLDS (dB) OF CHILDREN AGED 6 TO 17 YEARS. MEANS NOT CONNECTED BY LINES ARE SIGNIFICANTLY DIFFERENT FROM EACH OTHER AT THE 0.05 LEVEL OF SIGNIFICANCE, AS DETERMINED BY DUNCAN'S MULTIPLE RANGE TEST.

	Frequency				
	6000 Hz	4000 Hz	500 Hz	1000 Hz	2000 Hz
Boys					
left ear	1.82	0.67	-1.31	-1.51	-2.09
right ear	1.16	0.96	0.06	-0.63	-1.38
Girls					
left ear	-0.05	-0.01	-2.45	-3.06	-3.57
right ear	-0.34	-0.39	-1.37	-2.15	-2.89

A considerable proportion of the participants have thresholds at -10 to -12 dB. The latter is the lower limit of the audiometer used in this study. The proportion of children with thresholds at or below -10 dB is often over 15 percent and tends to be higher in older than in younger children. Figures 12 through 17 present representative examples of this phenomenon, namely, the proportions of boys and girls hearing at each threshold level at 4000 Hz in the right ear.

One explanation for the relative lack of younger children hearing at attenuation levels of -10 and -12 dB and the significant negative correlations with age is that younger children may not concentrate sufficiently to reach their "true" thresholds. This explanation would account for the slightly higher means of the younger children and the significant correlations. If the difference between the age groups is real, and not due to sampling error, nor lack of concentration in younger children, an alternative explanation is that hearing improves with age as a result of some developmental or environmental change.

TABLE 34 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN AGE AND AUDITORY THRESHOLD IN RIGHT EAR, LEFT EAR, BETTER EAR AND WORSE EAR OF ALL EXAMINATIONS IN BOYS AND GIRLS

Frequency (Hz)	n	Boys Correlation Coefficient	n	Girls Correlation Coefficient
Right Ear				
500	563	-0.24 **	538	-0.41 **
1000	566	-0.23 **	542	-0.35 **
2000	567	-0.15 **	543	-0.26 **
4000	567	-0.12 **	542	-0.28 **
6000	565	-0.10 *	541	-0.20 **
M512	563	-0.26 **	538	-0.41 **
D4	566	-0.12 **	541	0.01
Left Ear				
500	551	-0.26 **	522	-0.37 **
1000	555	-0.12 **	527	-0.30 **
2000	561	-0.15 **	528	-0.31 **
4000	559	-0.05	525	-0.15 **
6000	555	-0.12 **	525	-0.12 **
M512	551	-0.24 **	521	-0.38 **
D4	555	-0.15 **	523	-0.09 **
Better Ear				
500	566	-0.28 **	538	-0.43 **
1000	567	-0.22 **	542	-0.37 **
2000	567	-0.17 **	543	-0.35 **
4000	567	-0.10 *	542	-0.27 **
6000	566	-0.14 **	541	-0.21 **
M512	566	-0.27 **	538	-0.44 **
D4	567	-0.14 **	541	-0.05
Worse Ear				
500	548	-0.25 **	522	-0.39 **
1000	554	-0.23 **	527	-0.31 **
2000	561	-0.16 **	528	-0.28 **
4000	559	-0.10 *	525	-0.20 **
6000	554	-0.11 *	525	-0.14 **
M512	548	-0.26 **	521	-0.37 **
D4	548	-0.16 **	523	-0.39

* $.01 < p \leq .05$
** $p \leq .01$

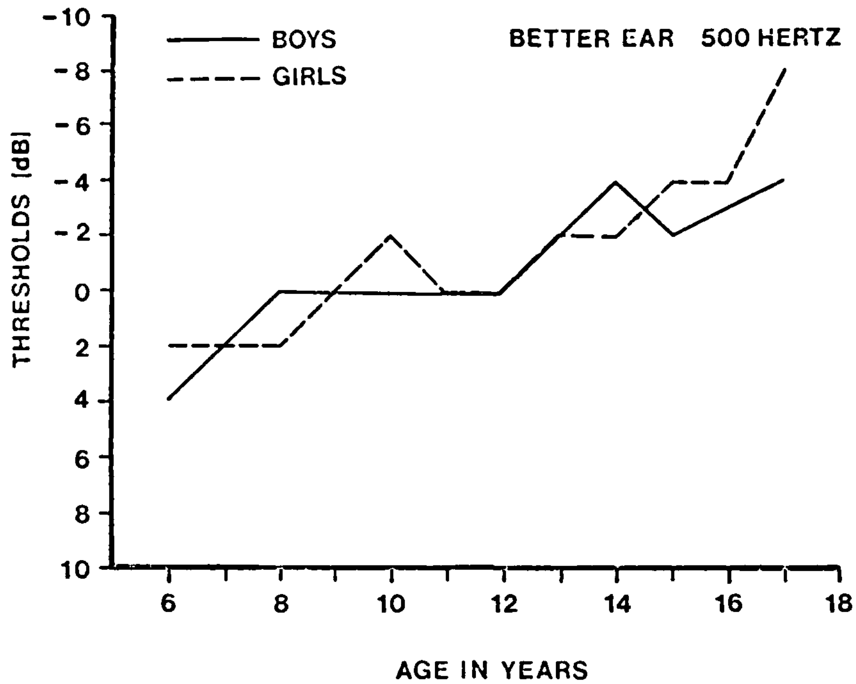

FIGURE 2 -MEDIAN AUDITORY THRESHOLDS (dB) AT 500 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS

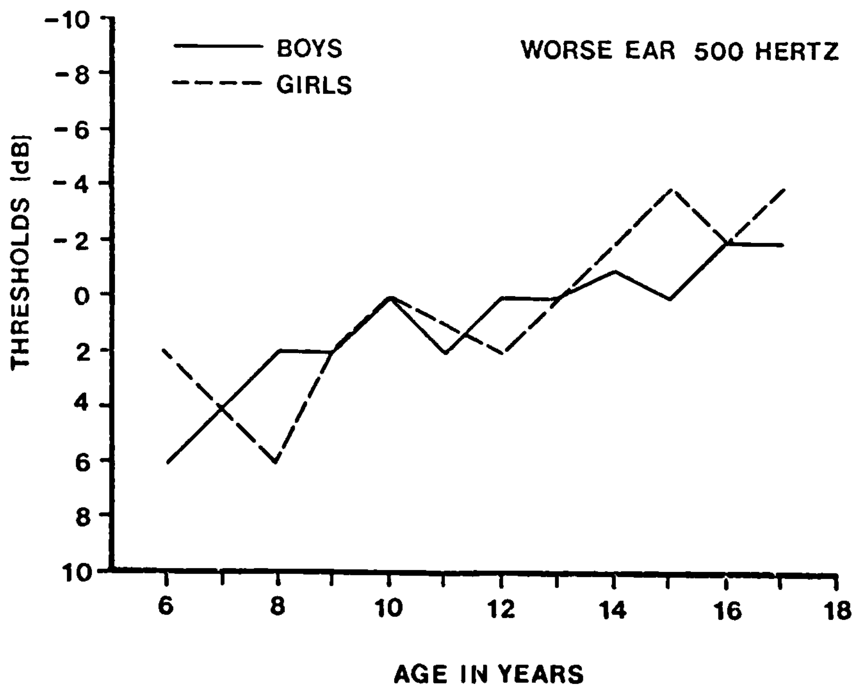

FIGURE 3 -MEDIAN AUDITORY THRESHOLDS (dB) AT 500 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

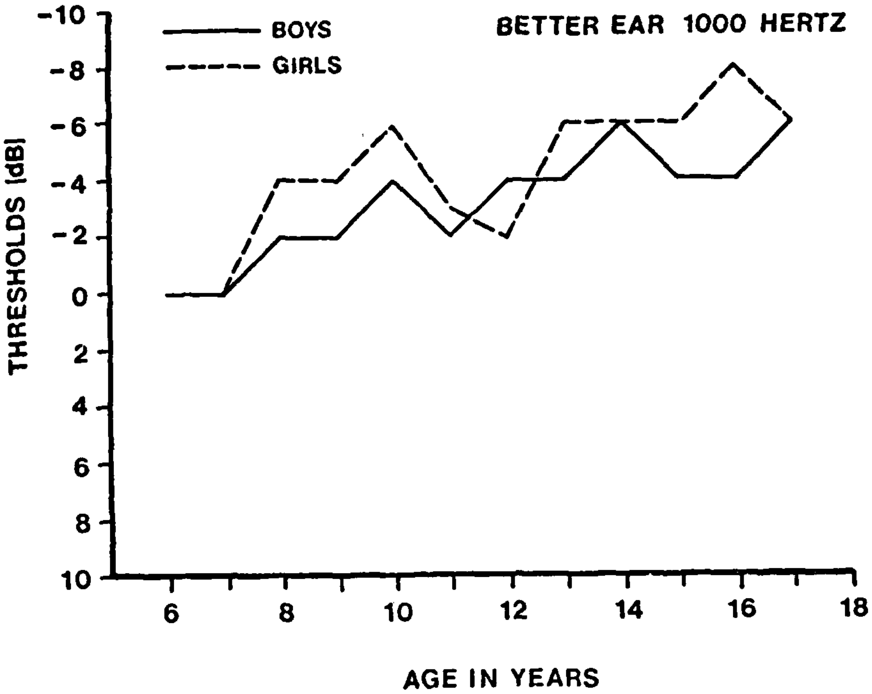

FIGURE 4 -MEDIAN AUDITORY THRESHOLDS (dB) AT 1000 Hz COMPARING THE BETTER EAR OF BOYS AND CIRLS

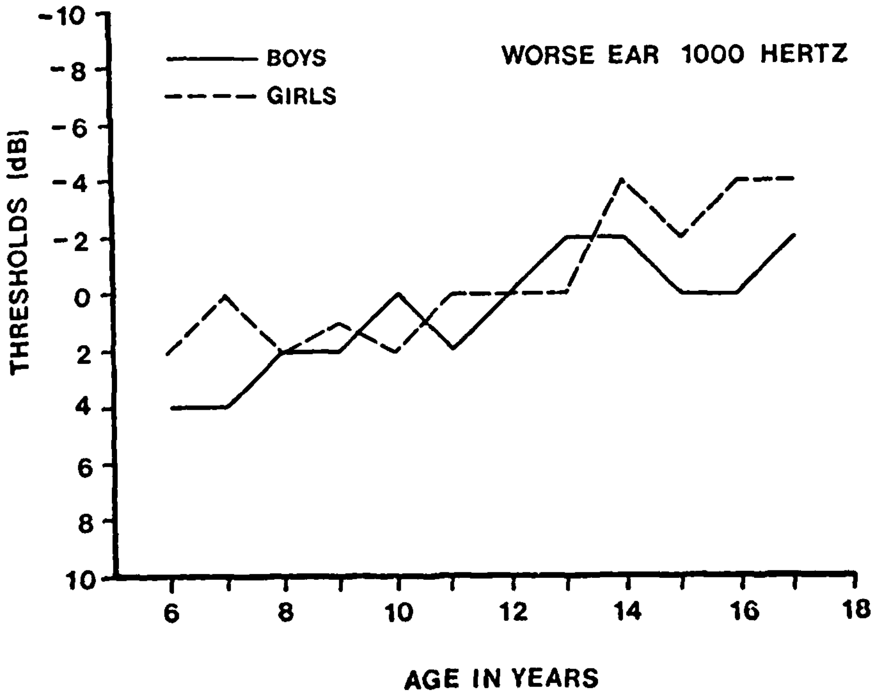

FIGURE 5 -MEDIAN AUDITORY THRESHOLDS (dB) AT 1000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

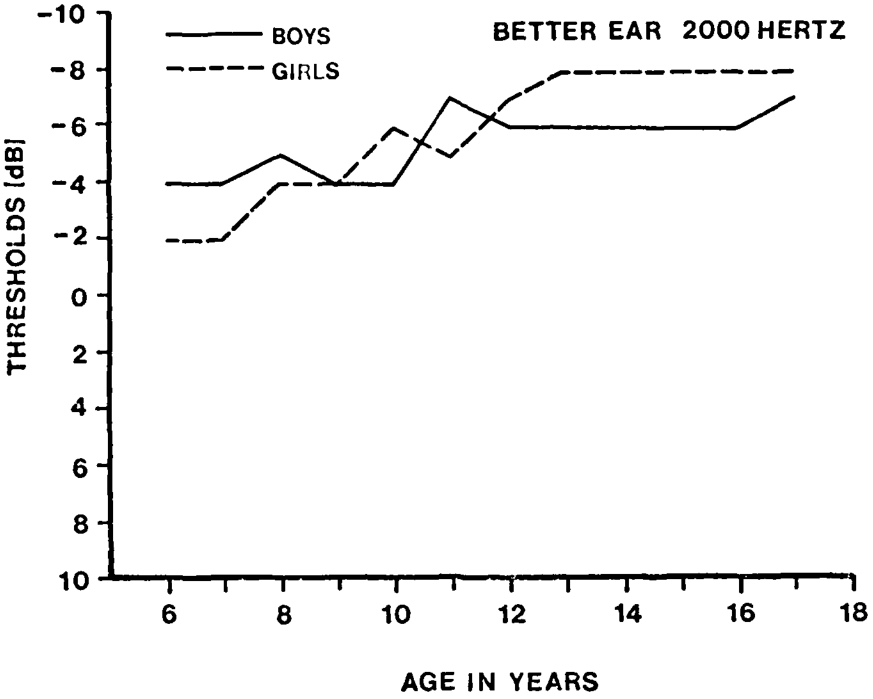

FIGURE 6 -MEDIAN AUDITORY THRESHOLDS (dB) AT 2000 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS

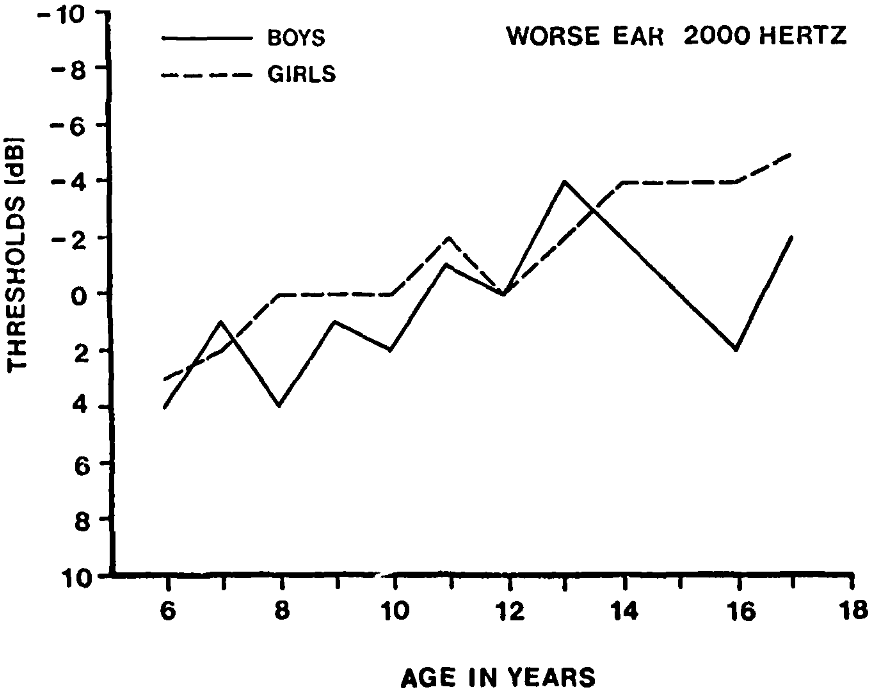

FIGURE 7 -MEDIAN AUDITORY THRESHOLDS (dB) AT 2000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

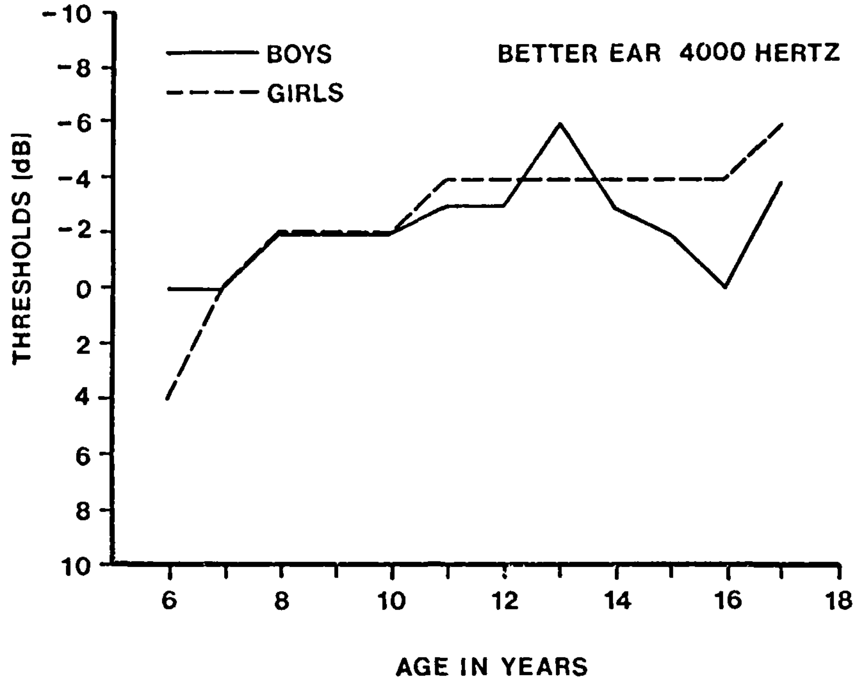

FIGURE 8 -MEDIAN AUDITORY THRESHOLDS (dB) AT 4000 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS

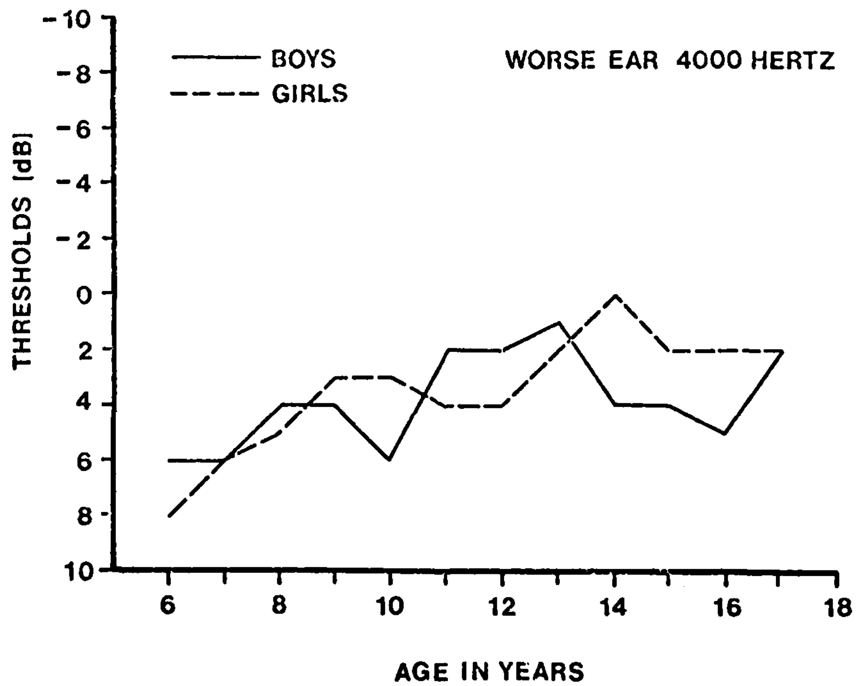

FIGURE 9 -MEDIAN AUDITORY THRESHOLDS (dB) AT 4000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

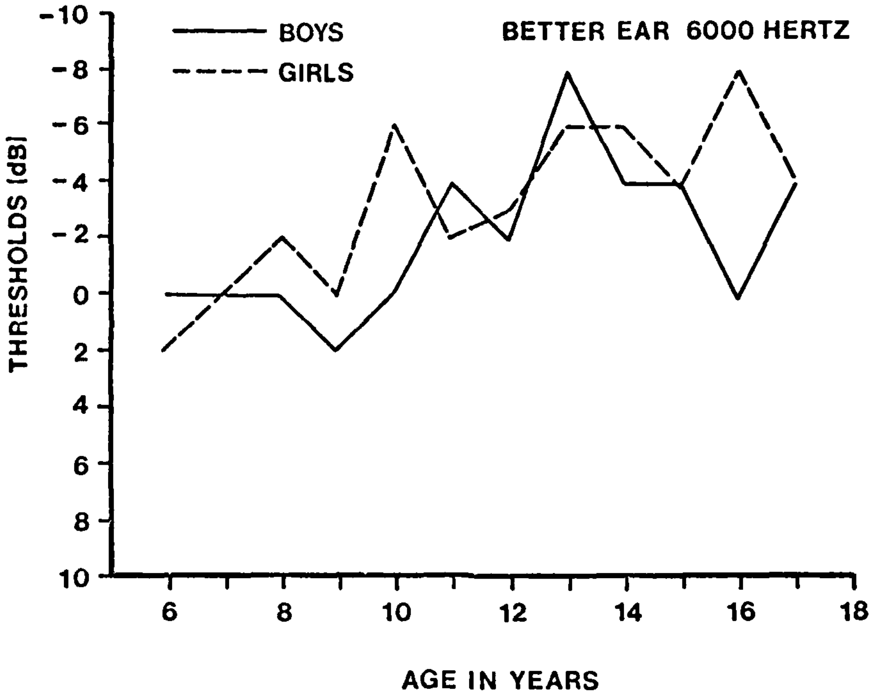

FIGURE 10 -MEDIAN AUDITORY THESHOLDS (dB) AT 6000 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS

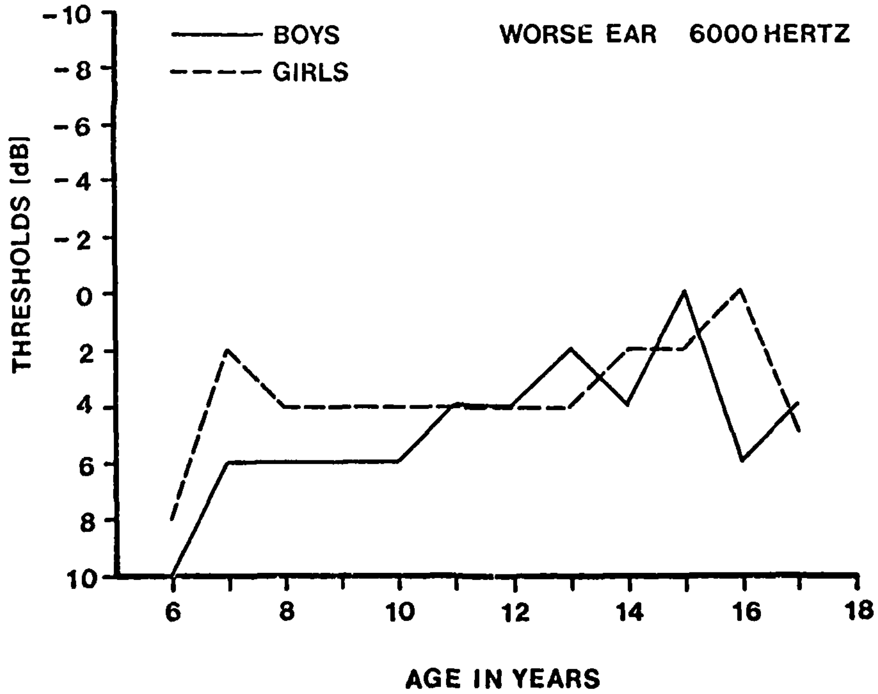

FIGURE 11 -MEDIAN AUDITORY THESHOLDS (dB) AT 6000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

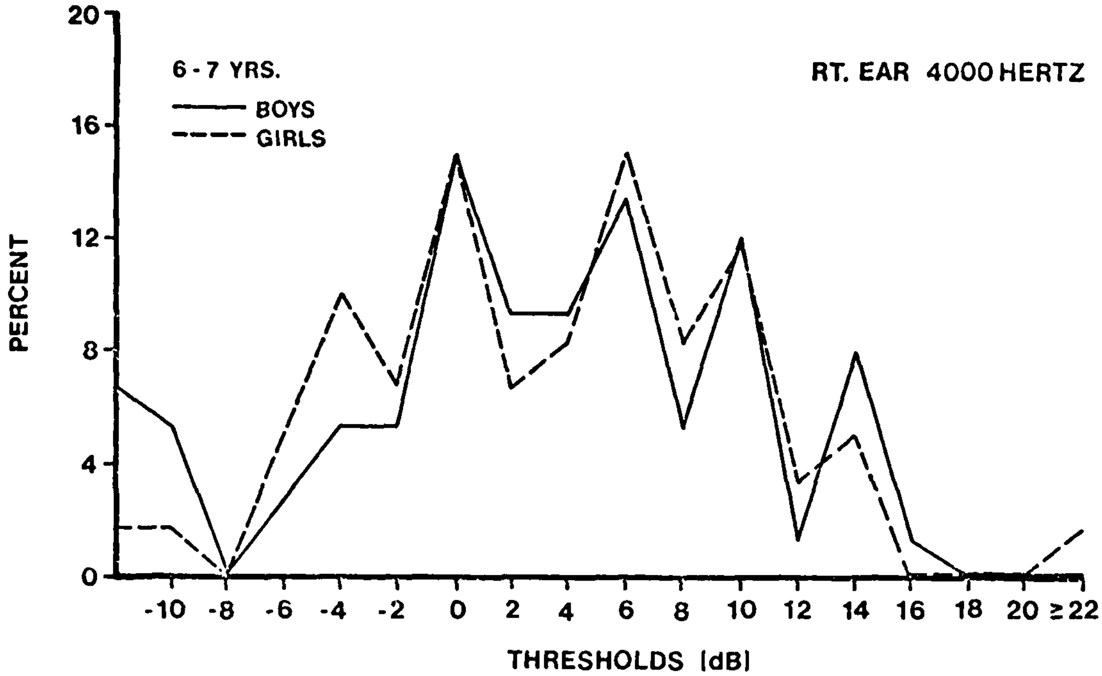

FIGURE 12 -PROPORTION OF EXAMINATIONS OF CHILDREN 6-7 YEARS OLD HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

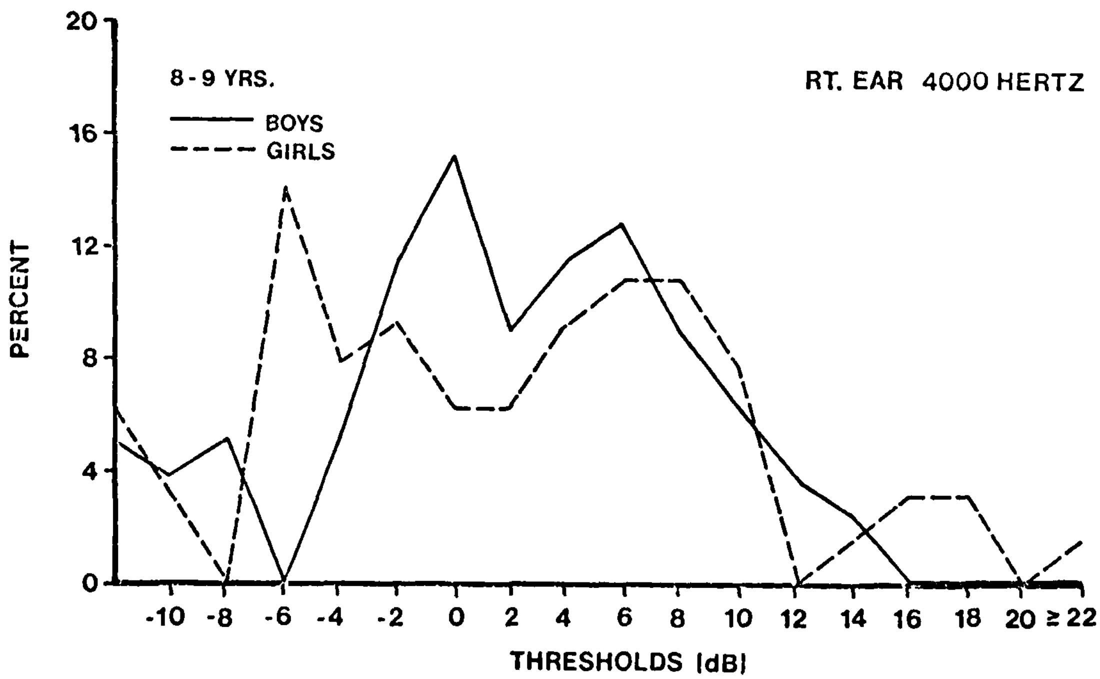

FIGURE 13 -PROPORTION OF EXAMINATIONS OF CHILDREN 8-9 YEARS OLD HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

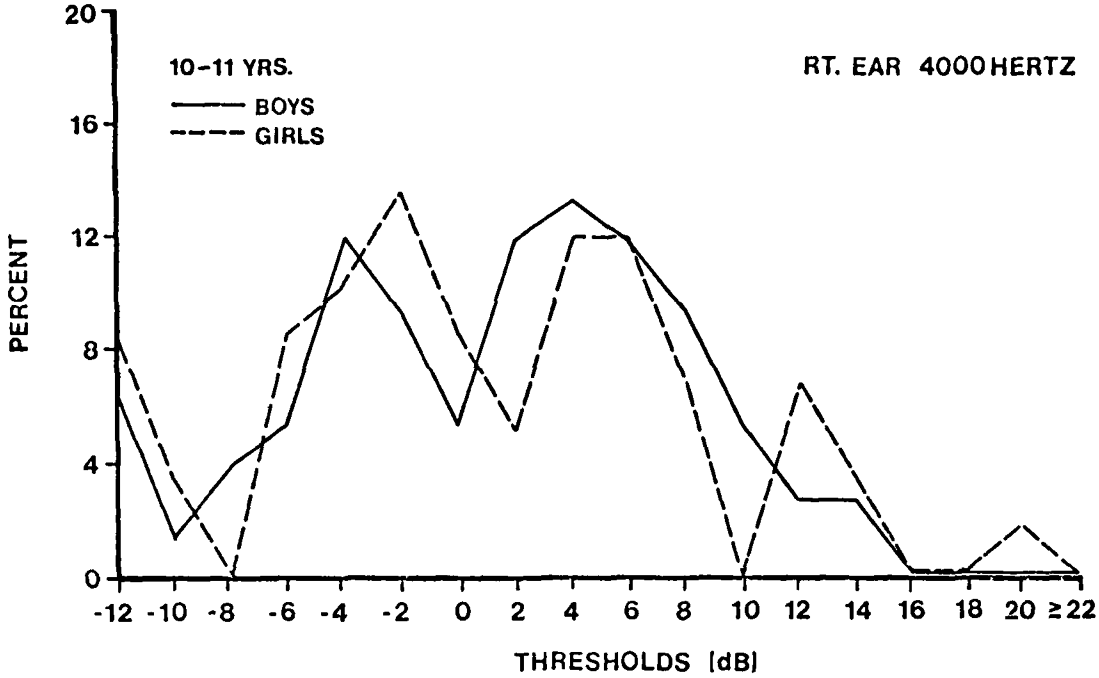

FIGURE 14 -PROPORTION OF EXAMINATIONS OF CHILDREN 10-11 YEARS OLD HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

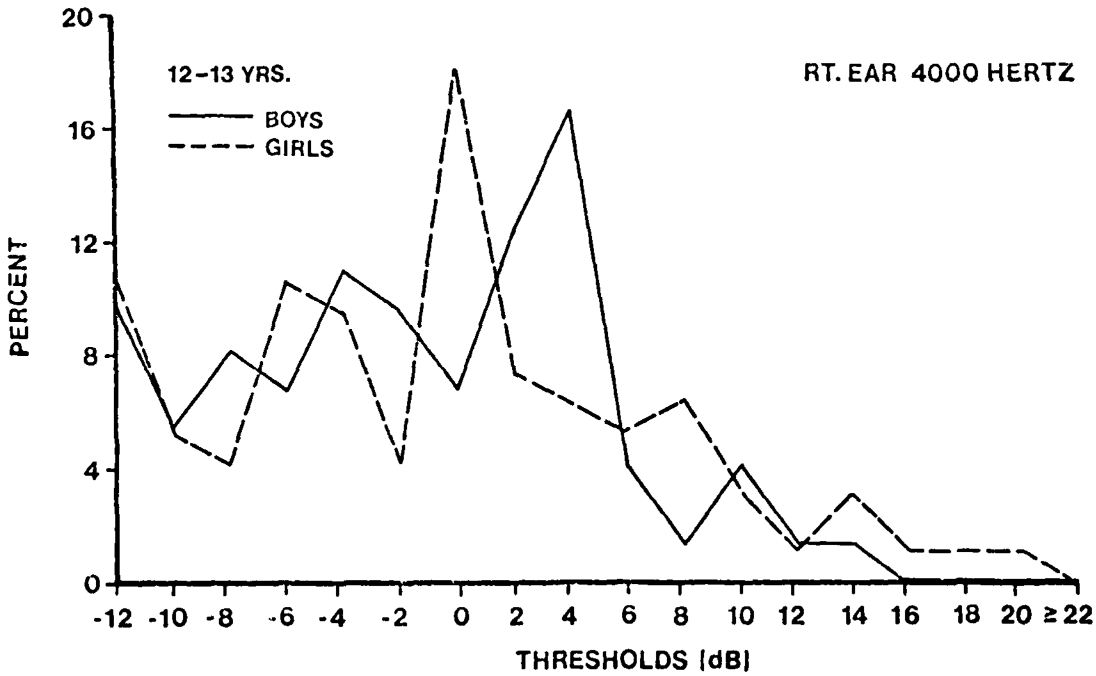

FIGURE 15 -PROPORTION OF EXAMINATIONS OF CHILDREN 12-13 YEARS OLD HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

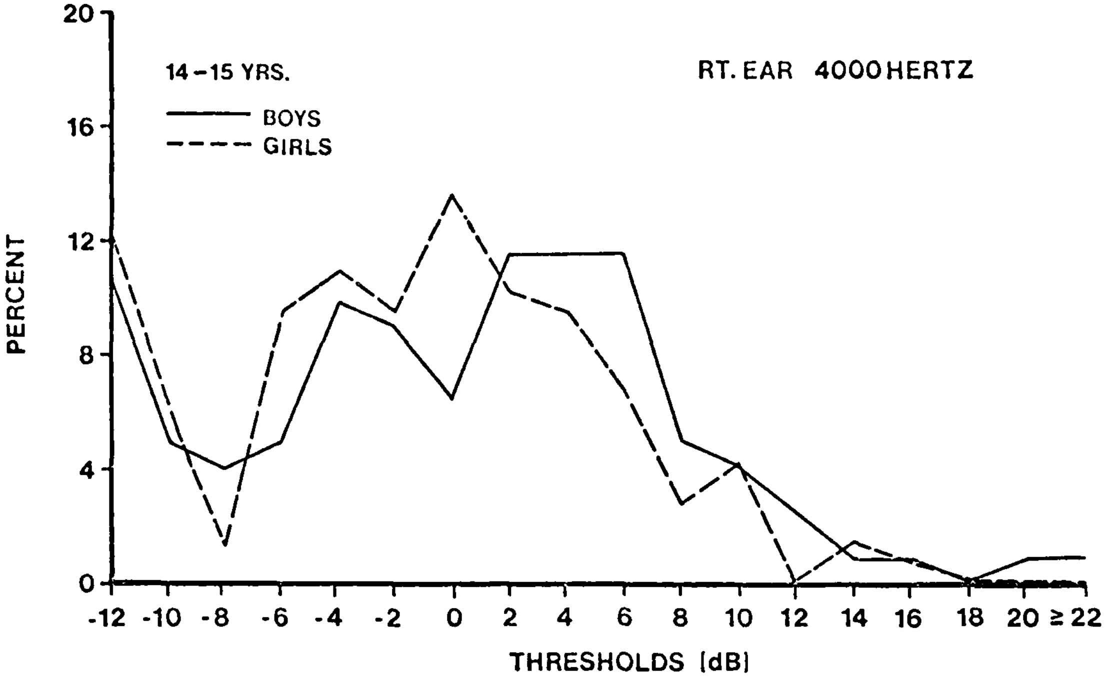

FIGURE 16 -PROPORTION OF EXAMINATIONS OF CHILDREN 14-15 YEARS OLD HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

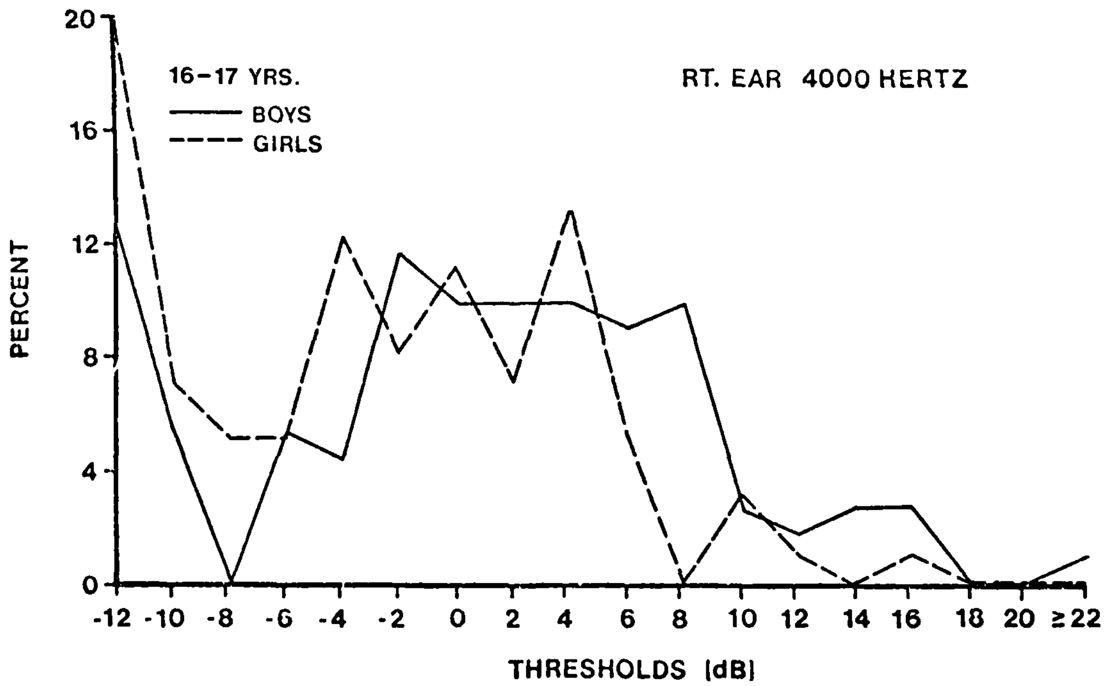

FIGURE 17 -PROPORTION OF EXAMINATIONS OF CHILREN 16-17 YEARS OLD HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR

Fels Auditory Thresholds Compared with National Data - Comparisons of the threshold distributions of the Fels and National Center for Health Statistics (NCHS) samples are presented in Figures 18 through 27. These figures show the proportion of the 12-to 17-year-old boys and girls in each sample that fall into six auditory threshold ranges. While these figures deal only with findings for the right ear, the results for the left ear are similar. The skewness and leptokurtosis of the distributions are evident. At each frequency, the Fels distribution is shifted toward lower thresholds (i.e., better hearing) compared to the NCHS distributions. The shape of the distribution and degree of shift is similar in males and females, except that the proportion of females in the lowest threshold category (-14 to -5 dB) is higher than in males at each frequency.

In Figures 28 through 37, the median threshold levels for the right ear of Fels boys and girls are presented with the corresponding NCHS medians at each age. The slight irregularity of the Fels curves is probably due to relatively small sample sizes at each age (see Figure 1). In general, for each sex, the Fels medians indicate lower thresholds compared to the National sample, and, the Fels and NCHS medians follow parallel courses across age. There is some variation at 2000 Hz where the Fels thresholds tend to decrease with age, whereas those from the National Center for Health Statistics show little change in either sex. A major exception is seen at 4000 Hz (Figures 34 and 35) where the NCHS data show a precipitous decrease (6 dB) in hearing ability between 11 and 12 years of age. It should be noted that the reference data for 6- to 11-year-olds, and those for 12- to 17-year-olds, are from different NCHS cross-sectional surveys. Consequently, the marked change in median thresholds from 11 to 12 years of age at 4000 Hz probably represents sampling error or instrument variation, rather than biological development. That this occurs in cross-sectional analyses, even those unusually well planned and based on large representative samples, such as NCHS, emphasizes the need for serial studies to establish the true changes. For determining hearing levels of the U. S. population as a whole, the best cross-sectional data available are those from NCHS. There are differences between the NCHS and Fels samples, e.g., sample sizes, age range, racial distribution, geographical distribution, screening and testing procedures.

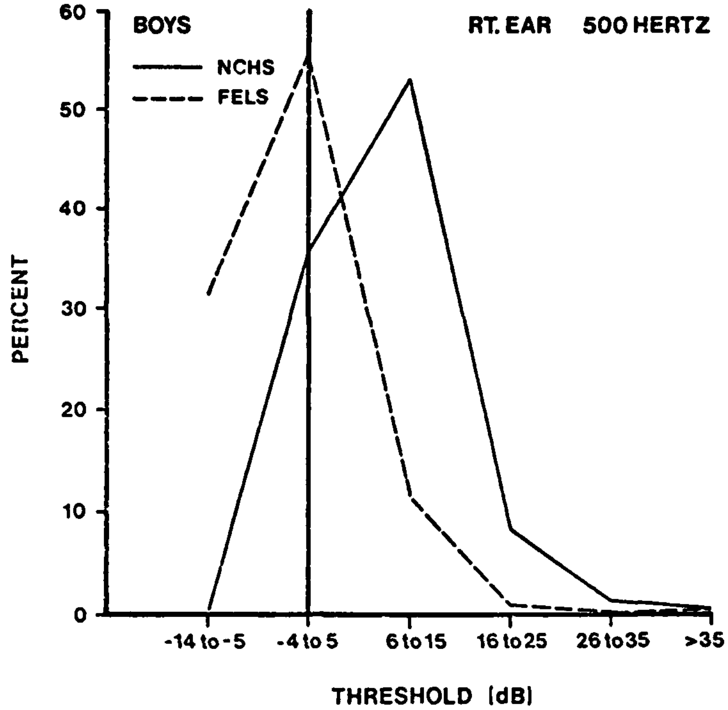

FIGURE 18 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 500 Hz, RIGHT EAR, BOYS

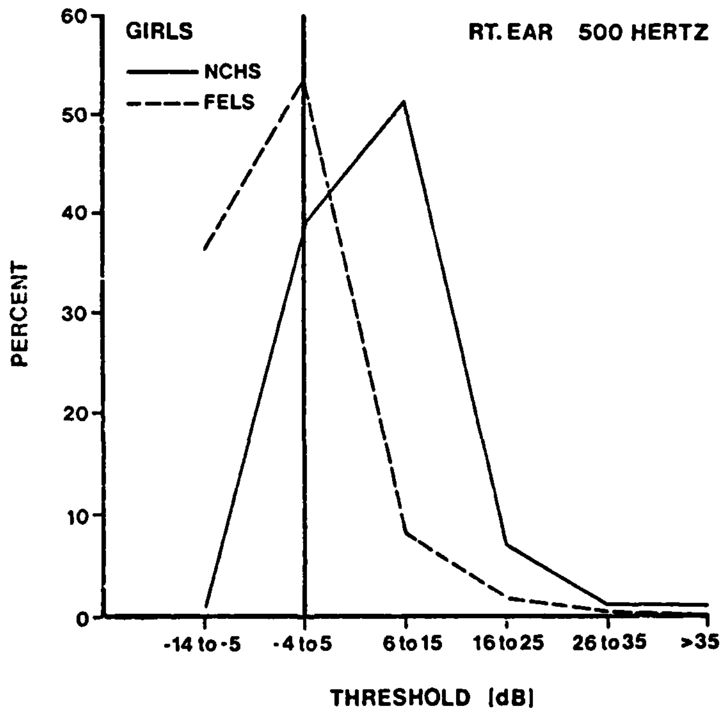

FIGURE 19 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 500 Hz, RIGHT EAR, GIRLS

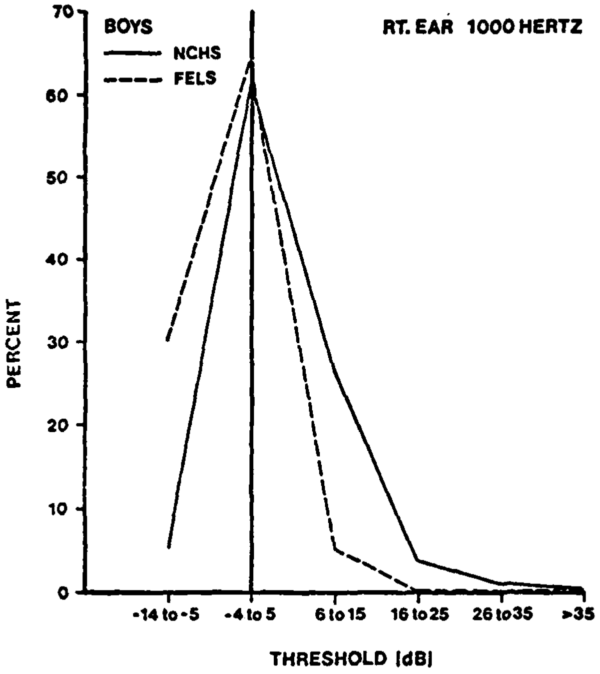

FIGURE 20 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 1000 Hz, RIGHT EAR, BOYS

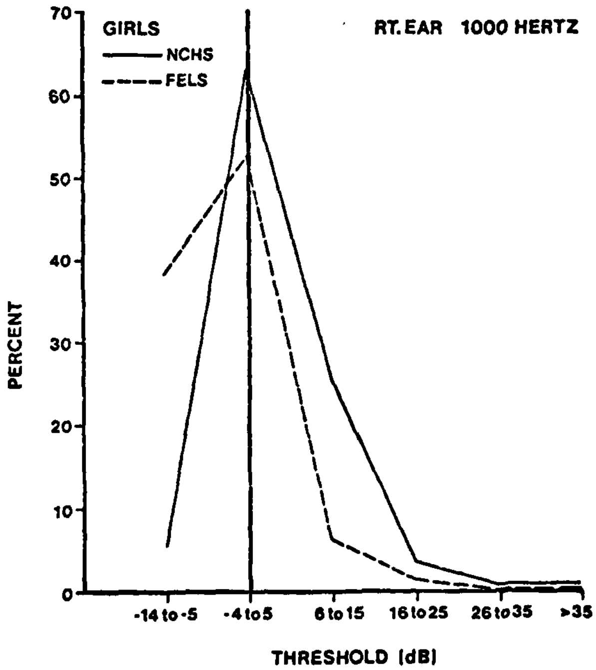

FIGURE 21 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 1000 Hz, RIGHT EAR, GIRLS

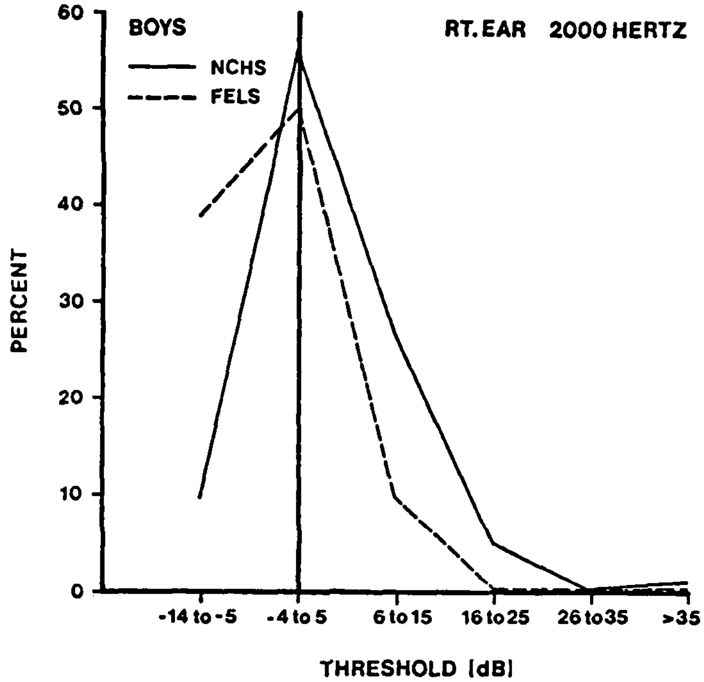

FIGURE 22 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 2000 Hz, RIGHT EAR, BOYS

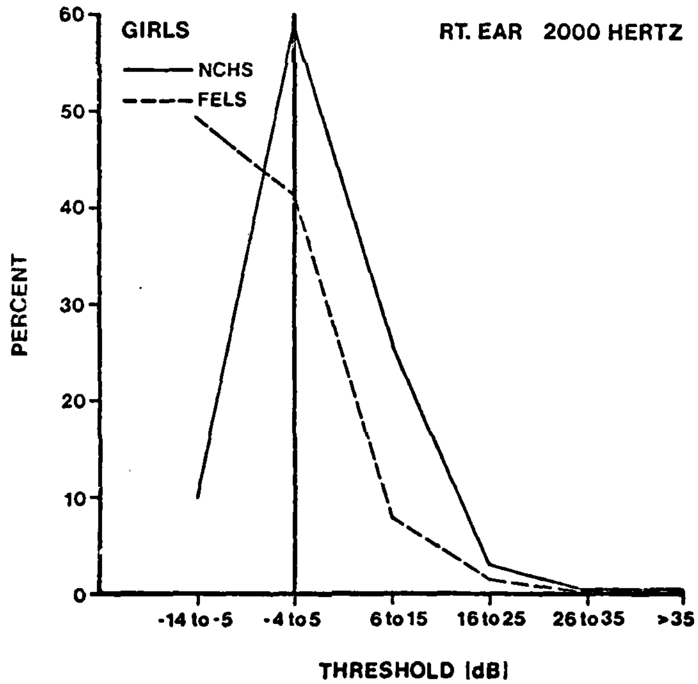

FIGURE 23 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 2000 Hz, RIGHT EAR, GIRLS

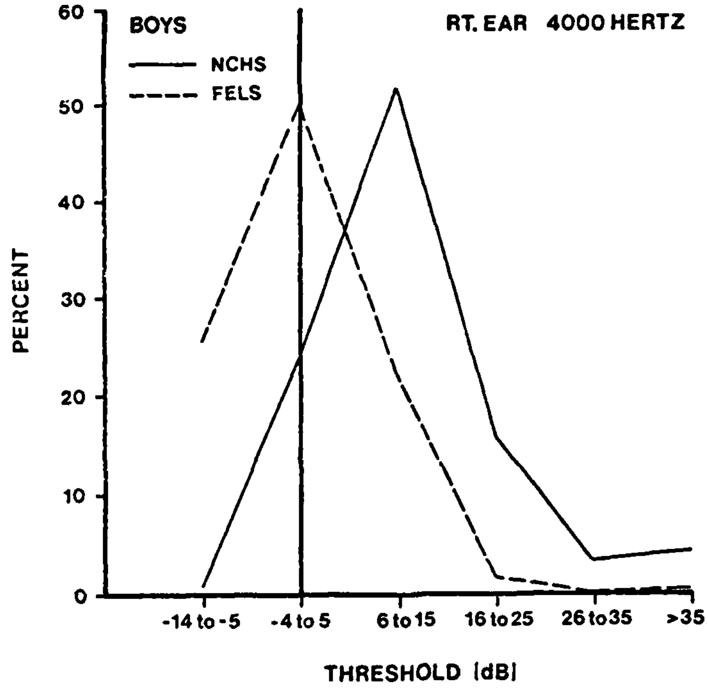

FIGURE 24 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 4000 Hz, RIGHT EAR, BOYS

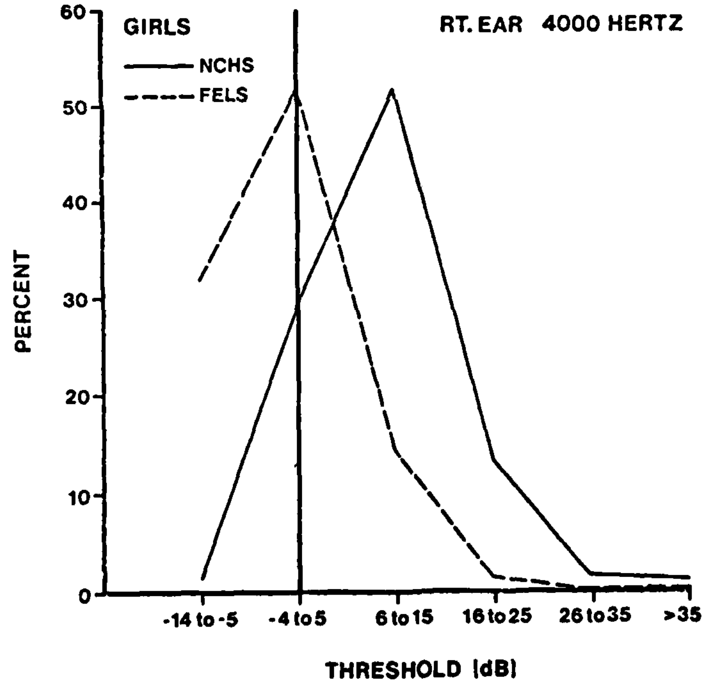

FIGURE 25 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 4000 Hz, RIGHT EAR, GIRLS

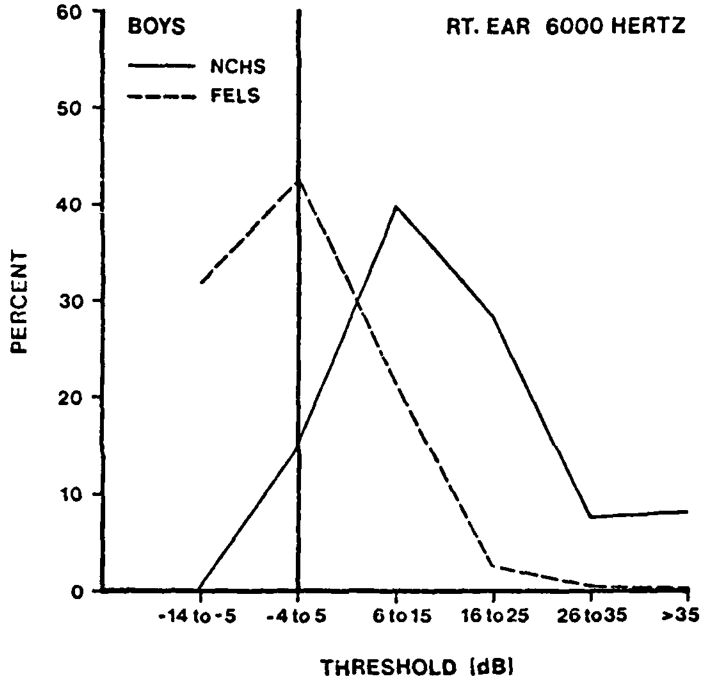

FIGURE 26 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 6000 Hz, RIGHT EAR, BOYS

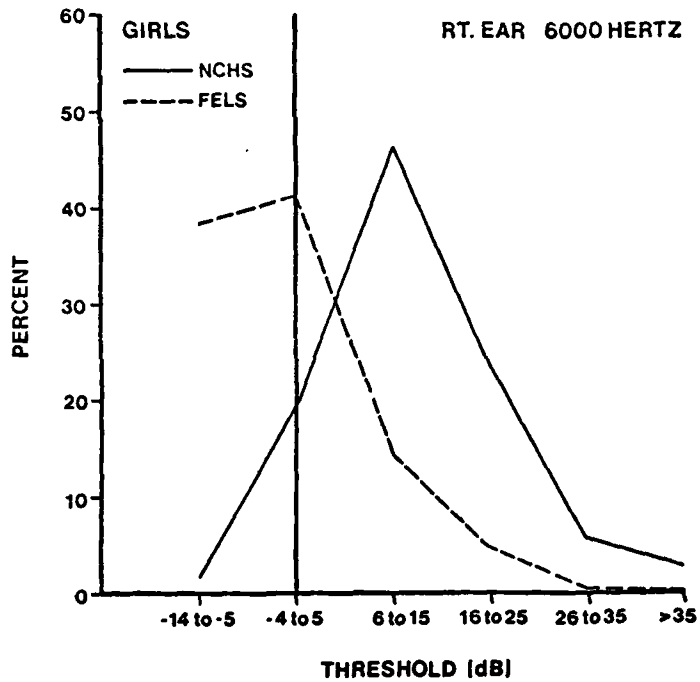

FIGURE 27 -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 6000 Hz, RIGHT EAR, GIRLS

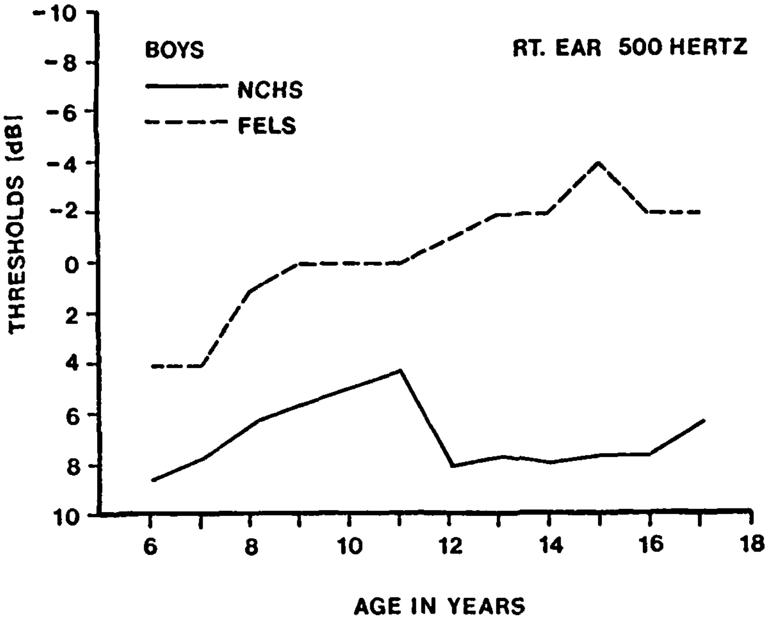

FIGURE 28 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 500 Hz IN THE RIGHT EAR OF BOYS

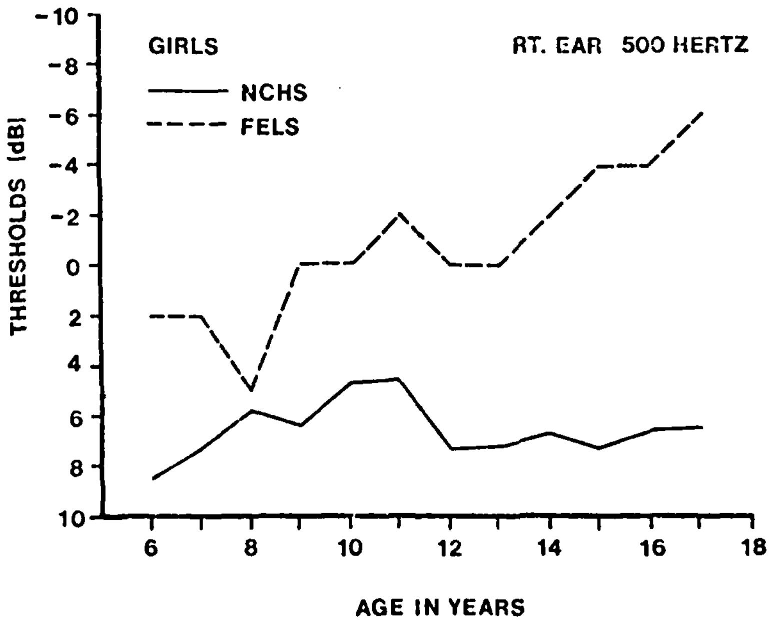

FIGURE 29 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 500 Hz IN THE RIGHT EAR OF GIRLS

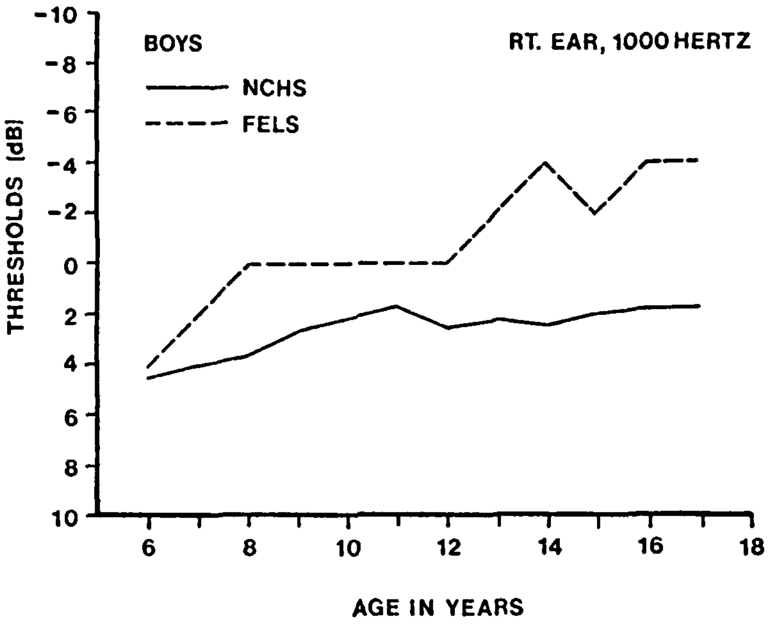

FIGURE 30 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 1000 Hz IN THE RIGHT EAR OF BOYS

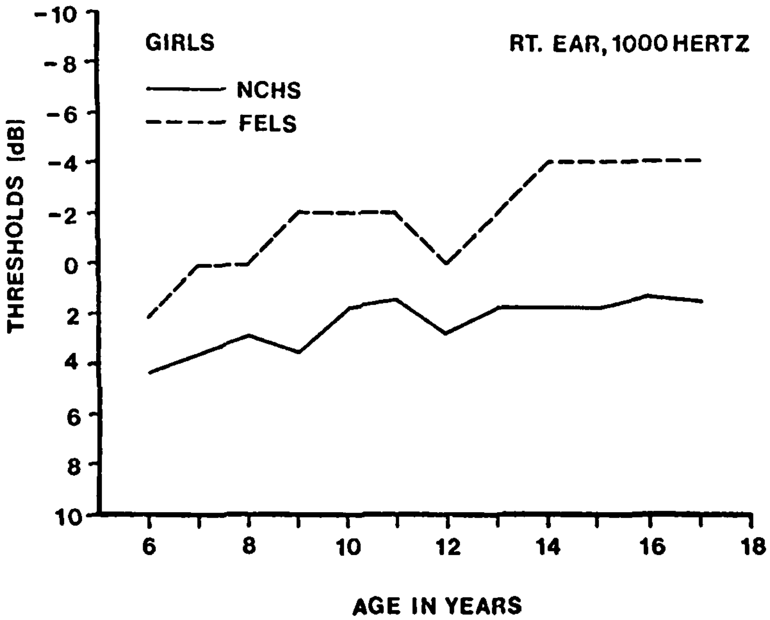

FIGURE 31 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 1000 Hz IN THE RIGHT EAR OF GIRLS

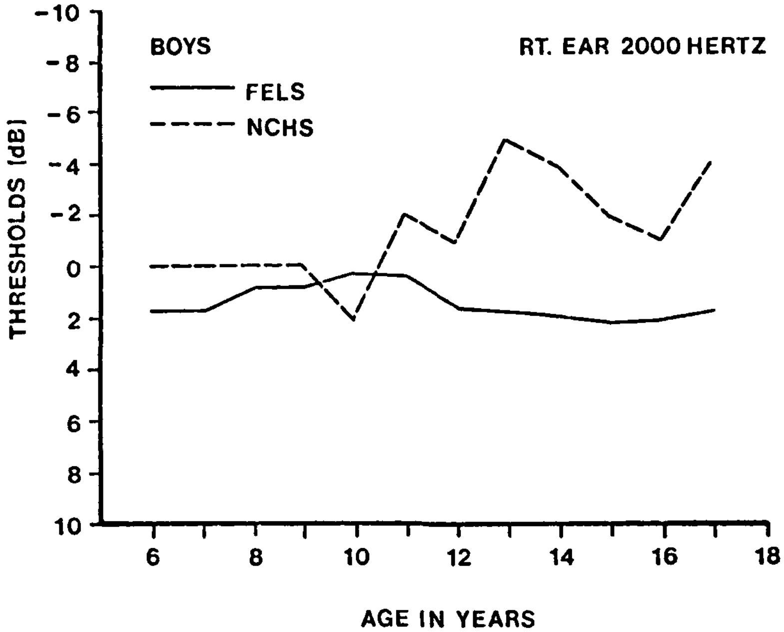

FIGURE 32 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 2000 Hz IN THE RIGHT EAR OF BOYS

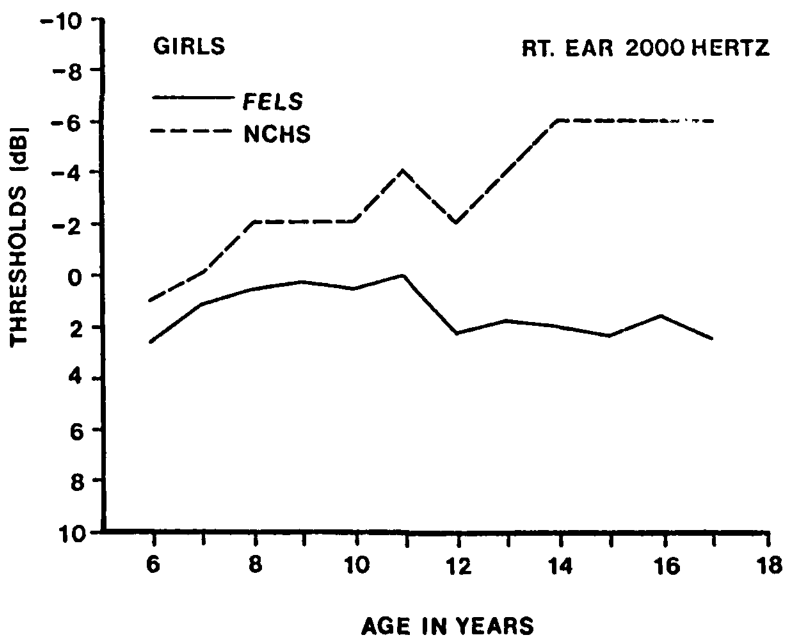

FIGURE 33 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 2000 Hz IN THE RIGHT EAR OF GIRLS

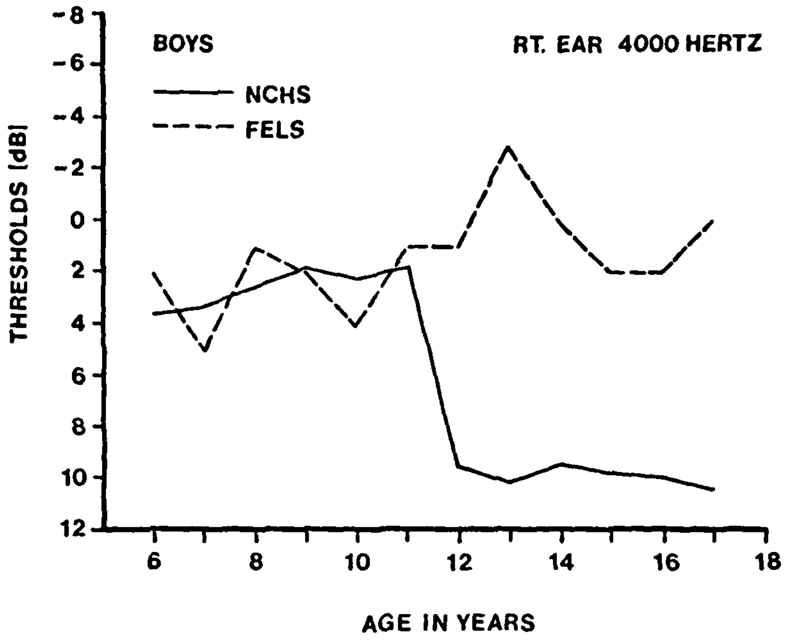

FIGURE 34 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR OF BOYS

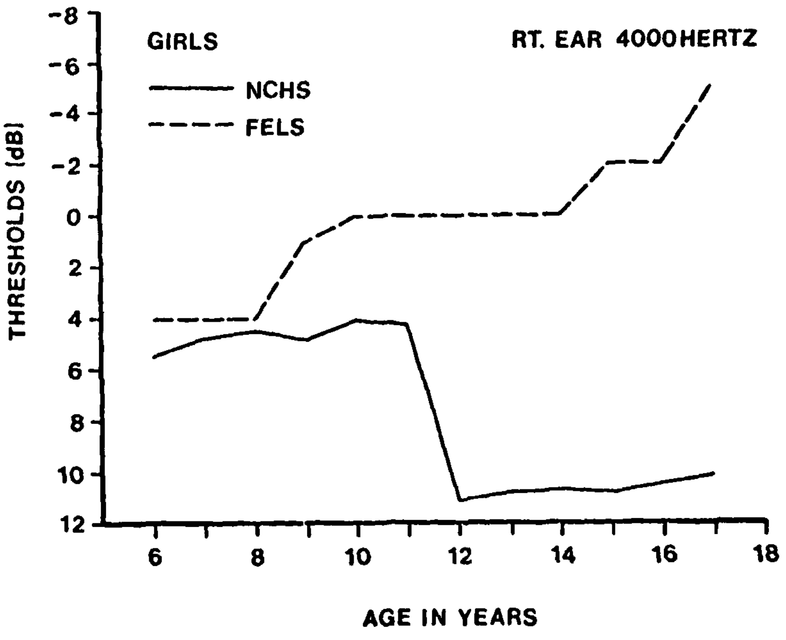

FIGURE 35 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR OF GIRLS

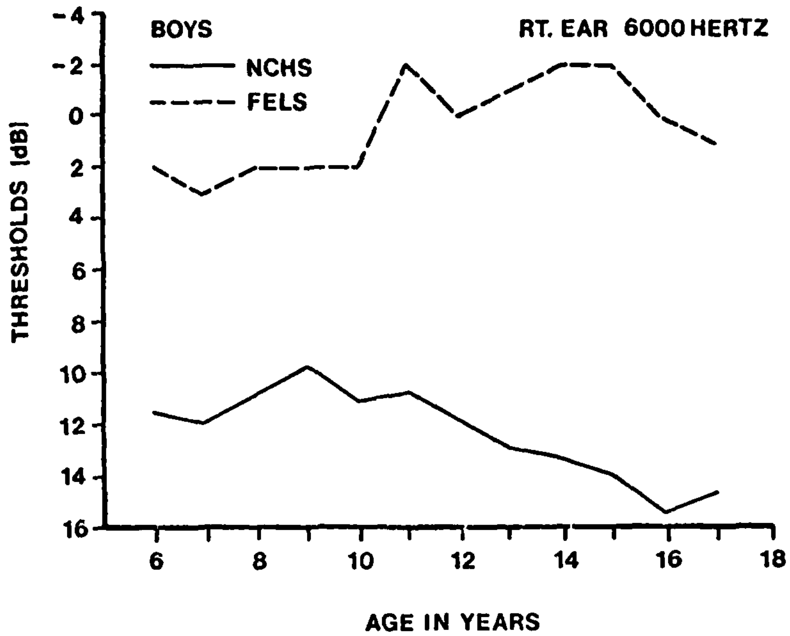

FIGURE 36 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 6000 Hz IN THE RIGHT EAR OF BOYS

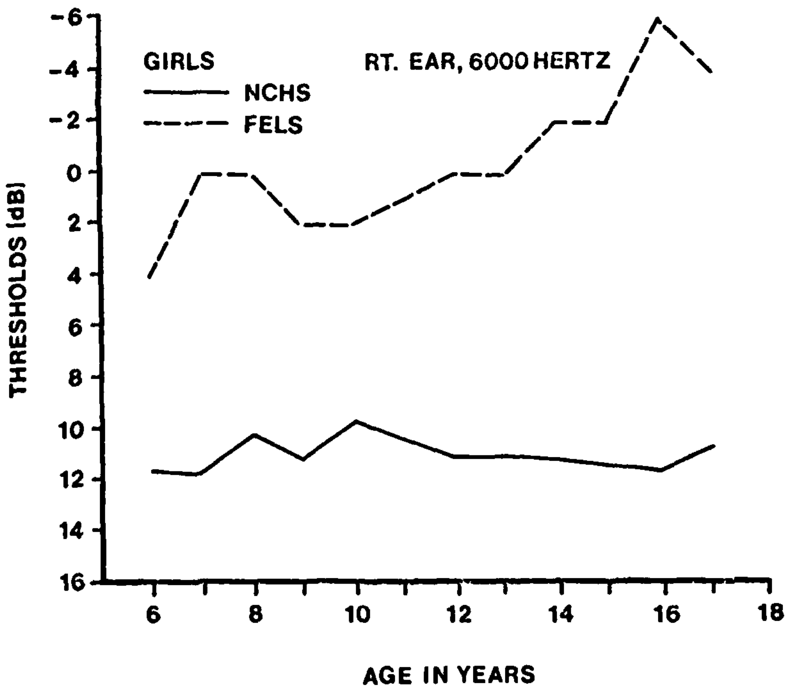

FIGURE 37 -FELS AND NCHS SAMPLES (ROBERTS AND HUBER,1970; ROBERTS AND AHUJA,1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 6000 Hz IN THE RIGHT EAR OF GIRLS

Increments - The increments are the changes in threshold levels from one visit to the next. They are calculated so that a positive value indicates a rise in threshold and, therefore, a change in the direction of a hearing loss. The calculations are made from pairs of examinations and represent a time interval of 5 to 7 months. The total number of 6-month increments between the ages of 6 and 17 years is 701. The age distribution of the children at the increment examinations is given in Table 35. Increments at each annual age for boys and girls 6 through 17 years of age are given in Tables 36 through 59. At each annual age and for each sex, the sample size, mean increment, standard deviation and quartiles are presented for each ear. Mean increments significantly different from zero are indicated with asterisks.

Only 7.5 percent of the mean increments are significantly different from zero at the 0.05 level of significance (asterisks in Tables 36 through 59); few more than expected by chance. There is a higher proportion of significant increments at the older ages (i. e., 16 and 17 years) and when significant differences occur, they tend to be negative. In fact, about 68 percent of the mean increments for right and left ears are negative; this implies that at each subsequent examination, children tend to hear better than at the previous one.

There are no apparent changes in increments associated with age at any frequency, except as already mentioned, there appear to be more increments that are statistically significant from zero at the older ages in both boys and girls. Spearman rank correlation coefficients between age and 6-month auditory threshold increments (Table 60) are not significantly different from zero in boys or girls at any frequency or in any ear.

Increments appear to be approximately normally distributed about a mean of zero in boys and girls at every frequency and at every age. Figures 38 through 43 show histograms of the number of examinations at 4000 Hz (right ear) in each increment class of boys and girls. These figures are representative of the shape and positioning of the distributions at other frequencies and those in the left ear.

Lateral Differences - Tables 9 through 32 give descriptive statistics for left less right auditory thresholds at each frequency, at each annual age in boys and girls. There is little evidence of an age or sex trend in lateral differences. However, the mean thresholds for the left ear are lower than right ear means at corresponding frequencies in about 60 percent of the cases, considering both sexes across all ages (Tables 9 through 32). Twice as many differences (21/220) are significant at the 0.05 level of significances than expected due to chance, and almost all of these (19) are negative. The lateral differences that are significantly different from zero are often in the range of -1 to -3 dB, indicating higher thresholds in the right ear.

TABLE 35 - AGE DISTRIBUITON OF 6-MONTHLY AUDITORY THRESHOLD INCREMENT EXAMINATIONS

Age in years	Number of increments in Boys	Number of increments in Girls
5.75- 6.74	11	12
6.75- 7.74	23	19
7.75- 8.74	26	27
8.75- 9.74	24	20
9.75-10.74	25	21
10.75-11.74	25	23
11.75-12.74	25	23
12.75-13.74	23	36
13.75-14.74	37	49
14.75-15.74	51	53
15.75-16.74	49	47
16.75-17.74	32	20

TABLE 36 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	11	-0.18	10.33	-8.0	0.0	8.0
1000	11	3.82	9.18	-2.0	2.0	10.0
2000	11	2.91	6.77	-2.0	4.0	6.0
4000	11	-2.91	7.45	-8.0	-2.0	0.0
6000	11	0.55	6.20	-4.0	0.0	4.0
M512	11	2.00	7.04	-4.0	1.0	5.0
D4	11	6.73**	7.11	0.0	4.0	16.0
D1	11	-1.64	4.37	-4.0	-2.0	4.0
LEFT EAR						
500	7	4.29	7.70	0.0	4.0	6.0
1000	8	3.50	7.91	-2.0	2.0	10.0
2000	11	4.91*	5.54	0.0	4.0	10.0
4000	9	4.22	10.74	-6.0	10.0	12.0
6000	8	-1.00	10.31	-7.0	-1.0	3.5
M512	7	2.86	5.55	-2.0	2.0	5.0
D4	8	0.00	10.58	-10.5	1.0	6.0
D1	8	-2.75	5.12	-8.5	-2.0	1.5
BETTER EAR						
500	11	1.45	9.43	-4.0	4.0	4.0
1000	11	1.82	6.42	-2.0	2.0	4.0
2000	11	1.45	4.48	-2.0	0.0	6.0
4000	11	-1.09	8.22	-6.0	-4.0	4.0
6000	11	-0.91	8.73	-6.0	0.0	2.0
M512	11	1.09	5.20	-2.0	0.0	3.0
D4	11	2.91	7.76	0.0	6.0	6.0
WORSE EAR						
500	7	1.71	9.55	-6.0	0.0	6.0
1000	8	6.25	10.00	-1.0	5.0	13.0
2000	11	6.36**	6.62	2.0	8.0	10.0
4000	9	2.00	10.82	-8.0	8.0	11.0
6000	8	1.00	6.59	-4.0	-1.0	6.0
M512	7	3.43	5.94	-1.0	2.0	8.0
D4	8	5.25	8.28	-3.0	3.0	14.0
LEFT-RIGHT DIFFERENCES						
500	7	7.14	13.90	-2.0	2.0	12.0
1000	8	-1.50	9.55	-6.0	-4.0	7.5
2000	11	2.00	8.29	-6.0	2.0	6.0
4000	9	7.11	10.78	-1.0	8.0	16.0
6000	8	-1.00	9.26	-11.0	2.0	7.0
M512	7	2.43	7.02	-3.0	1.0	8.0

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 37 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	9	-2.22	7.10	-7.0	-2.0	4.0
1000	11	-2.18	4.85	-6.0	-2.0	0.0
2000	12	0.00	7.34	-5.5	-1.0	7.0
4000	10	-1.20	8.18	-7.0	0.0	4.5
6000	9	-5.33	7.55	-10.0	-8.0	2.0
M512	9	-1.33	4.56	-4.5	0.0	2.0
D4	9	-3.33	6.78	-9.0	-4.0	2.0
D1	11	1.82	3.52	0.0	2.0	4.0
LEFT EAR						
500	7	6.86	11.94	0.0	2.0	10.0
1000	7	5.43	6.70	2.0	4.0	6.0
2000	8	2.25	6.27	-1.5	1.0	7.5
4000	8	4.00	10.31	-4.0	3.0	6.0
6000	7	3.43	11.00	-4.0	0.0	10.0
M512	7	4.71	7.97	0.0	4.0	4.0
D4	7	0.00	5.29	-2.0	-2.0	4.0
D1	7	0.29	2.93	-2.0	2.0	2.0
BETTER EAR						
500	9	-0.44	8.71	-6.0	2.0	5.0
1000	11	-0.18	6.78	-2.0	0.0	4.0
2000	12	0.50	6.33	-4.0	0.0	7.5
4000	10	-0.20	8.46	-2.5	0.0	5.5
6000	9	-4.00	8.89	-11.0	-2.0	3.0
M512	9	0.44	5.22	-1.0	1.0	3.5
D4	9	-1.56	4.56	-5.0	0.0	2.0
WORSE EAR						
500	7	4.57*	3.95	2.0	4.0	6.0
1000	7	0.57	3.78	-2.0	0.0	2.0
2000	8	1.50	5.32	-3.5	0.0	7.0
4000	8	2.75	7.63	-1.5	2.0	3.5
6000	7	0.57	10.44	-10.0	0.0	6.0
M512	7	1.71	4.03	-1.0	0.0	3.0
D4	7	-3.43	4.86	-6.0	-2.0	0.0
LEFT-RIGHT DIFFERENCES						
500	7	6.29	15.25	-2.0	0.0	12.0
1000	7	8.29	9.55	2.0	4.0	12.0
2000	8	-0.50	10.99	-7.0	2.0	6.0
4000	8	2.00	11.56	-7.5	2.0	10.5
6000	7	9.71	13.54	2.0	6.0	12.0
M512	7	4.29	10.18	-2.0	4.0	4.0

* $.01 < p \leq .05$

TABLE 38 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	20	0.70	5.81	-3.5	0.0	4.0
1000	20	1.10	7.24	-4.0	1.0	5.5
2000	22	-0.82	7.35	-6.0	-3.0	8.0
4000	22	-0.18	8.70	-6.5	0.0	4.0
6000	22	-0.45	6.47	-4.5	-1.0	2.5
M512	20	0.30	5.39	-4.0	-0.5	3.3
D4	20	2.00	6.84	-2.0	3.0	6.0
D1	20	-0.90	4.18	-3.5	0.0	3.0
LEFT EAR						
500	20	-1.70	7.00	-6.0	-3.0	2.0
1000	21	2.29	8.16	-3.0	2.0	9.0
2000	22	-0.18	5.92	-4.0	0.0	4.0
4000	21	0.00	8.12	-4.0	0.0	5.0
6000	20	-2.90	7.85	-7.5	-1.0	1.5
M512	20	0.20	5.60	-4.0	0.0	5.0
D4	21	2.29	9.30	-6.0	2.0	10.0
D1	21	-0.38	4.22	-4.0	0.0	3.0
BETTER EAR						
500	22	-1.64	8.27	-4.5	-1.0	4.0
1000	22	1.27	8.81	-5.0	2.0	6.5
2000	22	-0.09	6.52	-4.5	0.0	4.0
4000	22	-0.55	9.99	-6.5	0.0	6.0
6000	22	-1.27	7.00	-6.0	-2.0	2.5
M512	22	0.05	6.31	-4.3	0.0	5.0
D4	22	1.82	8.26	-4.0	2.0	6.0
WORSE EAR						
500	18	-0.33	5.54	-4.0	-2.0	1.0
1000	19	1.68	6.51	-2.0	2.0	6.0
2000	22	-0.91	6.13	-4.5	-2.0	2.5
4000	21	-0.38	7.31	-3.0	0.0	4.0
6000	20	-2.30	6.10	-6.0	-2.0	1.5
M512	18	0.00	4.43	-2.5	-1.0	3.3
D4	19	2.63	8.87	-4.0	2.0	12.0
LEFT-RIGHT DIFFERENCES						
500	18	-2.44	7.05	-7.0	-3.0	6.0
1000	19	1.37	5.42	-2.0	0.0	4.0
2000	22	0.64	6.21	-4.0	0.0	4.5
4000	21	-0.10	8.80	-4.0	0.0	4.0
6000	20	-2.50	8.85	-8.0	-4.0	3.5
M512	18	0.11	4.51	-3.0	-1.0	4.3

TABLE 39 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	19	-0.95	6.54	-6.0	-2.0	4.0
1000	19	0.00	5.66	-6.0	2.0	6.0
2000	19	-1.05	6.58	-8.0	-2.0	4.0
4000	19	-1.05	4.82	-4.0	-2.0	2.0
6000	19	-0.53	8.24	-4.0	-2.0	2.0
M512	19	-0.58	4.76	-2.0	0.0	1.0
D4	19	1.05	4.13	-2.0	2.0	4.0
D1	19	-0.32	5.78	-2.0	0.0	2.0
LEFT EAR						
500	14	-2.43	10.87	-6.5	0.0	3.0
1000	16	-0.25	9.60	-6.0	2.0	7.5
2000	16	-1.13	7.97	-5.5	1.0	4.0
4000	15	-3.20	10.39	-6.0	-2.0	2.0
6000	15	-2.53	11.94	-6.0	-4.0	8.0
M512	14	-0.79	8.70	-2.0	1.5	4.3
D4	15	3.87*	5.26	0.0	2.0	8.0
D1	16	-0.50	3.61	-2.0	-2.0	2.0
BETTER EAR						
500	19	-2.11	7.53	-6.0	0.0	2.0
1000	19	0.42	6.62	-6.0	0.0	6.0
2000	19	-1.26	5.42	-4.0	-2.0	2.0
4000	19	-1.58	6.27	-6.0	-2.0	2.0
6000	19	-0.84	7.07	-4.0	-2.0	4.0
M512	19	-0.84	5.34	-2.0	0.0	1.0
D4	19	2.00	4.99	-2.0	2.0	6.0
WORSE EAR						
500	14	-2.14	9.20	-6.0	-1.0	2.0
1000	16	-0.87	7.12	-5.5	2.0	4.0
2000	16	-1.13	7.73	-7.5	1.0	5.5
4000	15	-2.53	6.95	-6.0	-2.0	2.0
6000	15	-2.13	12.41	-8.0	-2.0	6.0
M512	14	-0.79	7.14	-2.3	0.5	3.0
D4	15	2.53*	4.50	2.0	2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	14	-1.57	8.49	-4.5	-1.0	4.0
1000	16	-0.75	9.06	-7.5	1.0	5.5
2000	16	0.37	7.94	-6.0	0.0	7.5
4000	15	-2.80	9.25	-6.0	-2.0	2.0
6000	15	-2.67	10.16	-4.0	-2.0	2.0
M512	14	-1.14	6.02	-4.0	0.5	2.5

* $.01 < p \leq .05$

TABLE 40 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	-2.08	8.24	-8.0	0.0	3.0
1000	25	-2.32	7.34	-8.0	0.0	4.0
2000	25	-0.16	5.47	-4.0	0.0	4.0
4000	25	-1.20	7.02	-5.0	-2.0	3.0
6000	25	-0.72	6.16	-6.0	0.0	4.0
M512	25	-1.44	5.04	-5.5	0.0	2.5
D4	25	-1.12	8.39	-6.0	-2.0	4.0
D1	25	-0.40	4.40	-4.0	-2.0	4.0
LEFT EAR						
500	25	-0.88	6.91	-3.0	0.0	3.0
1000	25	-2.56*	5.31	-6.0	-2.0	0.0
2000	25	-1.04	6.19	-3.0	0.0	4.0
4000	25	-3.36*	6.99	-8.0	-2.0	2.0
6000	25	-1.68	7.18	-6.0	-2.0	2.0
M512	25	-1.40	4.43	-3.0	-2.0	2.5
D4	25	0.80	6.61	-3.0	0.0	7.0
D1	25	0.64	5.41	-2.0	0.0	4.0
BETTER EAR						
500	25	-1.04	5.89	-5.0	0.0	3.0
1000	25	-2.08	5.31	-6.0	-2.0	1.0
2000	25	-0.80	5.72	-5.0	0.0	4.0
4000	25	-3.04*	7.26	-7.0	-2.0	1.0
6000	25	-1.28	4.61	-4.0	0.0	0.0
M512	25	-1.20	4.24	-4.5	-1.0	1.5
D4	25	0.96	6.11	-4.0	0.0	6.0
WORSE EAR						
500	25	-1.92	8.55	-7.0	0.0	3.0
1000	25	-2.80*	5.92	-5.0	-2.0	0.0
2000	25	-0.40	3.92	-4.0	0.0	4.0
4000	25	-1.52	5.39	-6.0	-2.0	3.0
6000	25	-1.12	6.25	-6.0	-2.0	4.0
M512	25	-1.68	4.53	-4.5	-1.0	2.0
D4	25	-1.28	7.14	-7.0	0.0	5.0
LEFT-RIGHT DIFFERENCES						
500	25	1.20	6.81	-4.0	0.0	7.0
1000	25	-0.24	8.15	-5.0	0.0	6.0
2000	25	-0.88	8.08	-4.0	0.0	4.0
4000	25	-2.16	8.44	-8.0	-4.0	4.0
6000	25	-0.96	10.38	-8.0	0.0	6.0
M512	25	0.00	4.85	-2.0	0.0	3.0

* $.01 < p \leq .05$

TABLE 41 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	26	-0.92	8.56	-8.0	1.0	6.0
1000	27	-1.70	8.03	-6.0	0.0	4.0
2000	27	-0.89	10.13	-6.0	-2.0	4.0
4000	27	-1.70	7.29	-6.0	0.0	4.0
6000	27	-2.44	8.64	-8.0	-2.0	2.0
M512	26	-0.85	6.98	-7.3	-0.5	3.0
D4	27	0.00	6.97	-4.0	2.0	4.0
D1	27	0.37	4.93	-4.0	0.0	4.0
LEFT EAR						
500	25	-1.28	9.91	-10.0	-2.0	6.0
1000	25	-2.72	8.14	-6.0	-2.0	3.0
2000	25	-1.28	5.47	-6.0	-2.0	3.0
4000	25	-2.64	7.91	-10.0	-2.0	3.0
6000	25	-1.44	7.99	-7.0	-2.0	1.0
M512	25	-1.80	5.48	-6.5	-3.0	3.5
D4	25	-0.08	9.96	-5.0	2.0	7.0
D1	25	0.64	4.46	-3.0	0.0	3.0
BETTER EAR						
500	26	-1.15	9.02	-10.0	-2.0	6.0
1000	27	-2.74	7.71	-6.0	-2.0	4.0
2000	27	-1.04	4.45	-4.0	-2.0	2.0
4000	27	-2.96*	6.85	-8.0	-2.0	2.0
6000	27	-1.70	7.70	-6.0	-2.0	0.0
M512	26	-1.62	5.43	-6.0	-1.5	3.0
D4	27	0.22	8.78	-6.0	0.0	6.0
WORSE EAR						
500	25	-1.36	8.56	-8.0	2.0	5.0
1000	25	-2.00	8.35	-6.0	0.0	3.0
2000	25	-2.16	8.44	-6.0	0.0	2.0
4000	25	-1.28	7.14	-5.0	0.0	3.0
6000	25	-2.24	8.63	-8.0	0.0	2.0
M512	25	-1.64	6.53	-6.5	-1.0	2.0
D4	25	-0.72	8.14	-4.0	0.0	4.0
LEFT-RIGHT DIFFERENCES						
500	25	-0.08	7.27	-5.0	0.0	4.0
1000	25	-0.96	4.05	-4.0	0.0	2.0
2000	25	0.48	8.53	-4.0	0.0	4.0
4000	25	-0.64	8.60	-8.0	0.0	6.0
6000	25	0.32	7.04	-6.0	0.0	5.0
M512	25	-0.16	3.80	-3.0	-1.0	3.0

* $.01 < p \leq .05$

TABLE 42 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	24	-0.08	7.79	-2.0	0.0	4.0
1000	24	-0.67	6.97	-5.5	-3.0	4.0
2000	24	1.00	6.04	-3.5	0.0	5.5
4000	24	1.42	8.18	-3.5	1.0	7.5
6000	24	-1.08	6.07	-4.0	-1.0	1.5
M512	24	0.04	5.30	-3.7	-1.5	6.0
D4	24	-2.08	7.99	-7.5	0.0	2.0
D1	24	0.83	4.21	-1.5	0.0	3.5
LEFT EAR						
500	22	-0.18	6.11	-4.0	0.0	2.5
1000	22	-0.09	6.28	-4.5	0.0	4.5
2000	23	-1.91	4.80	-6.0	-2.0	2.0
4000	23	0.26	7.94	-6.0	0.0	6.0
6000	22	0.27	9.04	-6.0	1.0	6.0
M512	22	-0.73	4.40	-5.3	0.0	2.3
D4	22	0.09	5.61	-4.0	0.0	4.0
D1	22	-0.45	5.65	-2.0	0.0	2.0
BETTER EAR						
500	24	-0.08	5.73	-2.0	0.0	2.0
1000	24	-0.67	5.68	-4.0	0.0	4.0
2000	24	-0.83	5.47	-4.0	0.0	2.0
4000	24	0.67	7.43	-5.5	0.0	5.5
6000	24	-0.92	6.27	-5.5	-1.0	3.0
M512	24	-0.54	4.14	-3.7	0.0	2.0
D4	24	-1.33	6.77	-6.0	0.0	4.0
WORSE EAR						
500	22	-0.27	7.84	-2.5	0.0	2.5
1000	22	-0.09	7.29	-6.0	-1.0	6.0
2000	23	-0.26	5.63	-6.0	0.0	4.0
4000	23	1.04	7.31	-4.0	0.0	4.0
6000	22	-0.09	7.50	-6.0	0.0	6.0
M512	22	-0.27	5.21	-4.0	-0.5	3.3
D4	22	-0.55	6.77	-6.0	-2.0	4.5
LEFT-RIGHT DIFFERENCES						
500	22	-0.09	5.50	-4.0	0.0	2.5
1000	22	0.09	5.29	-4.0	0.0	4.5
2000	23	-3.22*	5.68	-10.0	-2.0	2.0
4000	23	-1.57	8.61	-8.0	-2.0	4.0
6000	22	1.18	9.50	-4.5	1.0	10.0
M512	22	-0.86	3.33	-3.0	0.0	1.2

* $.01 < p \leq .05$

TABLE 43 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	19	-0.32	6.44	-6.0	-2.0	4.0
1000	20	1.00	5.09	-2.0	2.0	4.0
2000	20	-1.00	4.66	-2.0	-2.0	2.0
4000	20	-0.90	7.80	-7.5	0.0	4.0
6000	20	-0.10	9.37	-3.5	0.0	5.5
M512	19	-0.05	3.52	-3.0	0.0	2.0
D4	20	1.90	7.72	-6.0	1.0	7.5
D1	20	-0.80	3.86	-2.0	-1.0	1.5
LEFT EAR						
500	17	-0.12	6.73	-5.0	0.0	7.0
1000	18	3.78 *	6.36	-0.5	5.0	8.0
2000	19	0.53	6.03	-4.0	0.0	6.0
4000	18	1.67	6.52	-4.0	1.0	6.5
6000	18	1.44	7.38	-2.5	0.0	7.0
M512	17	1.06	4.49	-1.5	0.0	5.5
D4	17	0.94	5.92	-3.0	0.0	6.0
D1	18	-1.89	3.97	-4.5	-2.0	2.0
BETTER EAR						
500	19	0.84	7.19	-4.0	-2.0	8.0
1000	20	1.80	5.69	-2.0	1.0	6.0
2000	20	-0.10	4.08	-4.0	0.0	3.5
4000	20	1.20	5.78	-3.5	2.0	6.0
6000	20	0.30	6.17	-2.0	0.0	4.0
M512	19	0.95	4.34	-2.0	0.0	5.0
D4	20	0.60	7.05	-4.0	0.0	6.0
WORSE EAR						
500	17	-1.41	5.28	-6.0	-2.0	1.0
1000	18	2.89 *	5.23	-0.5	2.0	6.5
2000	19	-0.42	5.40	-4.0	-2.0	2.0
4000	18	-0.78	7.00	-6.5	0.0	4.0
6000	18	0.11	8.72	-4.0	0.0	4.5
M512	17	0.00	3.18	-2.5	1.0	2.0
D4	17	2.59	7.54	-4.0	0.0	10.0
LEFT-RIGHT DIFFERENCES						
500	17	1.18	5.75	-4.0	0.0	5.0
1000	18	3.00	7.04	-1.5	2.0	8.5
2000	19	1.37	6.83	-2.0	2.0	6.0
4000	18	2.89	9.36	-4.0	2.0	6.5
6000	18	1.56	10.30	-4.0	1.0	8.5
M512	17	1.65	4.20	-1.0	0.0	3.5

* $.01 < p \leq .05$

TABLE 44 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	0.16	4.54	-2.0	0.0	3.0
1000	25	0.40	4.12	-2.0	2.0	4.0
2000	25	-0.80	4.28	-4.0	-2.0	2.0
4000	25	-1.12	7.03	-6.0	-2.0	5.0
6000	25	-1.60	7.30	-5.0	-2.0	3.0
M512	25	-0.20	3.08	-3.0	0.0	2.0
D4	25	1.52	7.73	-2.0	2.0	6.0
D1	25	-0.48	2.90	-2.0	0.0	2.0
LEFT EAR						
500	21	-0.95	7.53	-7.0	0.0	6.0
1000	24	-0.08	5.12	-4.0	0.0	3.5
2000	24	-0.33	5.80	-4.0	1.0	3.5
4000	24	0.75	6.07	-4.0	1.0	4.0
6000	24	0.17	9.00	-5.5	0.0	6.5
M512	21	-0.67	4.92	-4.0	0.0	2.0
D4	24	-0.83	5.17	-4.0	-2.0	1.5
D1	24	0.17	3.86	-1.5	0.0	2.0
BETTER EAR						
500	25	-0.72	6.08	-7.0	0.0	5.0
1000	25	0.48	4.05	-2.0	0.0	4.0
2000	25	-0.56	5.58	-5.0	0.0	4.0
4000	25	-0.80	5.80	-4.0	0.0	4.0
6000	25	-1.12	6.43	-5.0	-2.0	4.0
M512	25	-0.28	3.76	-2.5	0.0	2.0
D4	25	1.28	7.00	-4.0	0.0	7.0
WORSE EAR						
500	21	0.29	5.23	-3.0	0.0	4.0
1000	24	-0.17	4.93	-6.0	1.0	4.0
2000	24	-0.67	3.67	-4.0	0.0	2.0
4000	24	0.42	5.21	-4.0	0.0	4.0
6000	24	-0.33	7.29	-4.0	0.0	3.5
M512	21	-0.38	3.56	-3.0	0.0	3.5
D4	24	-0.58	4.31	-2.0	-2.0	2.0
LEFT-RIGHT DIFFERENCES						
500	21	-1.14	6.86	-6.0	-2.0	3.0
1000	24	-0.42	4.53	-3.5	-1.0	2.0
2000	24	0.67	5.58	-3.5	0.0	5.5
4000	24	2.25	9.55	-3.5	4.0	7.5
6000	24	1.83	11.65	-4.0	0.0	10.0
M512	21	-0.62	3.15	-3.0	0.0	2.0

TABLE 45 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	21	0.10	7.06	-4.0	-2.0	4.0
1000	21	1.33	7.11	-5.0	2.0	4.0
2000	21	-0.57	7.65	-6.0	-2.0	3.0
4000	21	-0.95	8.80	-7.0	0.0	5.0
6000	21	-1.81	7.92	-9.0	0.0	4.0
M512	21	0.19	4.95	-3.5	1.0	2.5
D4	21	2.29	9.51	-4.0	0.0	11.0
D1	21	-0.19	4.09	-4.0	0.0	3.0
LEFT EAR						
500	19	0.42	9.39	-6.0	-2.0	8.0
1000	20	-2.50	11.07	-12.0	-3.0	6.5
2000	20	-0.10	7.58	-5.0	0.0	2.0
4000	19	-1.16	8.20	-6.0	-2.0	4.0
6000	20	-4.00	8.58	-4.0	-4.0	0.0
M512	19	-0.16	6.91	-5.0	1.0	4.0
D4	19	-1.05	8.44	-10.0	-2.0	4.0
D1	20	2.10*	4.02	0.0	2.0	5.5
BETTER EAR						
500	21	-0.57	8.18	-6.0	-2.0	5.0
1000	21	0.19	7.87	-6.0	0.0	5.0
2000	21	-0.38	5.89	-4.0	0.0	2.0
4000	21	-1.24	6.97	-6.0	-2.0	2.0
6000	21	-3.62	8.45	-8.0	-2.0	2.0
M512	21	-0.38	5.74	-4.5	-1.0	3.5
D4	21	1.43	7.70	-3.0	2.0	7.0
WORSE EAR						
500	19	0.63	7.63	-6.0	-2.0	6.0
1000	20	-1.30	8.44	-8.0	-2.0	3.5
2000	20	-0.70	7.93	-6.0	-1.0	2.0
4000	19	-0.32	5.63	-4.0	0.0	4.0
6000	20	-2.10	6.76	-4.0	-2.0	3.0
M512	19	-0.16	5.80	-5.0	-1.0	4.0
D4	19	-0.63	7.43	-8.0	0.0	4.0
LEFT-RIGHT DIFFERENCES						
500	19	0.53	6.83	-4.0	0.0	4.0
1000	20	-3.30	10.12	-9.0	-3.0	4.5
2000	20	0.70	8.44	-3.5	0.0	7.0
4000	19	-1.47	11.05	-8.0	0.0	6.0
6000	20	-1.90	9.79	-11.5	-3.0	7.0
M512	19	-0.21	4.85	-4.0	0.0	3.0

* $.01 < p \leq .05$

TABLE 46 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	24	-1.08	4.93	-3.5	-1.0	3.5
1000	25	-0.08	4.45	-2.0	0.0	2.0
2000	25	-0.80	7.07	-4.0	-2.0	5.0
4000	25	-1.12	6.08	-4.0	0.0	2.0
6000	25	-1.12	10.28	-6.0	-2.0	6.0
M512	24	-0.79	3.09	-3.0	-1.0	2.0
D4	25	1.04	6.71	-3.0	0.0	5.0
D1	25	0.48	3.07	-2.0	0.0	3.0
LEFT EAR						
500	24	-0.83	5.72	-5.5	-1.0	2.0
1000	25	1.04	5.04	-2.0	0.0	6.0
2000	25	-1.36	4.07	-4.0	0.0	2.0
4000	25	-2.72*	6.37	-6.0	-2.0	0.0
6000	25	-1.28	7.21	-7.0	0.0	4.0
M512	24	-0.29	3.24	-2.8	-1.0	2.0
D4	25	3.76	8.78	-1.0	4.0	9.0
D1	25	-0.16	3.41	-3.0	0.0	2.0
BETTER EAR						
500	25	-0.32	4.35	-2.0	0.0	2.0
1000	25	0.48	4.46	-2.0	0.0	4.0
2000	25	-0.72	4.35	-3.0	0.0	2.0
4000	25	-1.60	6.58	-5.0	0.0	0.0
6000	25	-1.84	6.08	-6.0	0.0	3.0
M512	25	-0.20	2.69	-2.0	0.0	1.0
D4	25	2.08	8.24	-2.0	2.0	7.0
WORSE EAR						
500	23	-1.57	4.13	-4.0	-2.0	2.0
1000	25	0.48	3.57	-2.0	0.0	2.0
2000	25	-1.44	5.82	-4.0	-2.0	3.0
4000	25	-2.24	5.64	-5.0	-2.0	0.0
6000	25	-0.56	9.21	-8.0	2.0	6.0
M512	23	-1.04*	2.08	-3.0	-1.0	0.0
D4	25	2.72	7.30	-2.0	2.0	7.0
LEFT-RIGHT DIFFERENCES						
500	23	-0.17	8.04	-8.0	0.0	4.0
1000	25	1.12	6.08	-3.0	0.0	4.0
2000	25	-0.56	6.84	-5.0	0.0	3.0
4000	25	-1.60	4.86	-4.0	0.0	2.0
6000	25	-0.16	12.05	-8.0	2.0	8.0
M512	23	0.39	4.05	-2.0	0.0	2.0

* $.01 < p \leq .05$

TABLE 47 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	23	0.78	5.74	-2.0	0.0	4.0
1000	23	-1.13	8.20	-6.0	0.0	4.0
2000	23	0.87	7.00	-4.0	0.0	4.0
4000	23	-0.52	6.72	-8.0	0.0	6.0
6000	23	-1.57	7.58	-6.0	-2.0	4.0
M512	23	0.04	4.58	-3.0	-1.0	3.0
D4	23	-0.61	8.89	-6.0	-4.0	8.0
D1	23	0.78	5.52	-2.0	2.0	2.0
LEFT EAR						
500	23	-0.78	6.29	-4.0	-2.0	2.0
1000	23	-1.57	6.35	-6.0	0.0	2.0
2000	23	0.70	7.74	-2.0	2.0	6.0
4000	23	-0.87	9.87	-6.0	-2.0	4.0
6000	23	2.70	8.88	-4.0	6.0	10.0
M512	23	-0.48	4.62	-3.0	0.0	2.0
D4	23	-0.70	10.96	-4.0	0.0	4.0
D1	23	0.61	3.74	-2.0	0.0	4.0
BETTER EAR						
500	23	0.61	5.34	-2.0	0.0	4.0
1000	23	-0.87	5.18	-4.0	0.0	2.0
2000	23	0.61	5.77	-4.0	2.0	4.0
4000	23	-0.35	6.46	-6.0	0.0	4.0
6000	23	-0.43	6.93	-4.0	0.0	4.0
M512	23	0.17	3.89	-2.0	-1.0	2.0
D4	23	-0.52	6.50	-6.0	-2.0	4.0
WORSE EAR						
500	23	-0.61	5.64	-2.0	0.0	2.0
1000	23	-1.83	8.53	-8.0	0.0	4.0
2000	23	0.96	8.24	-4.0	2.0	6.0
4000	23	-1.04	8.78	-6.0	-2.0	4.0
6000	23	1.57	8.13	-4.0	2.0	8.0
M512	23	-0.52	5.20	-4.0	-1.0	3.0
D4	23	-0.78	10.88	-8.0	2.0	6.0
LEFT-RIGHT DIFFERENCES						
500	23	-1.57	6.41	-4.0	0.0	2.0
1000	23	-0.43	6.69	-4.0	-2.0	6.0
2000	23	-0.17	8.78	-4.0	0.0	6.0
4000	23	-0.35	10.59	-8.0	0.0	8.0
6000	23	4.26	10.61	0.0	6.0	10.0
M512	23	-0.57	3.51	-3.0	-1.0	3.0

TABLE 48 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	-2.08	5.49	-6.0	0.0	2.0
1000	25	-1.76	5.11	-5.0	-2.0	2.0
2000	25	1.28	5.88	-2.0	0.0	4.0
4000	25	-1.28	6.73	-6.0	0.0	4.0
6000	25	-1.28	7.35	-6.0	-4.0	3.0
M512	25	-0.64	3.71	-2.0	0.0	1.5
D4	25	-0.48	6.81	-6.0	-2.0	5.0
D1	25	-0.08	3.39	-2.0	0.0	2.0
LEFT EAR						
500	24	-1.50	5.96	-4.0	0.0	2.0
1000	24	-1.00	4.13	-2.0	-1.0	2.0
2000	24	1.08	6.10	-3.5	2.0	6.0
4000	24	-1.58	7.64	-8.0	-1.0	3.5
6000	24	-2.00	6.78	-7.5	-2.0	3.5
M512	24	-0.46	4.01	-2.0	0.0	2.8
D4	24	0.58	8.03	-4.0	-1.0	5.5
D1	24	0.33	3.10	-2.0	0.0	2.0
BETTER EAR						
500	25	-1.36	5.38	-4.0	0.0	2.0
1000	25	-1.04	4.73	-4.0	-2.0	2.0
2000	25	0.32	4.61	-4.0	0.0	5.0
4000	25	-1.64	6.43	-7.0	-2.0	3.0
6000	25	-0.96	6.35	-6.0	-2.0	3.0
M512	25	-0.64	3.85	-2.5	0.0	2.0
D4	25	0.80	6.24	-5.0	0.0	5.0
WORSE EAR						
500	24	-2.25	5.54	-5.5	0.0	2.0
1000	24	-1.75*	4.10	-4.0	-2.0	2.0
2000	24	1.75	6.02	-1.5	2.0	4.0
4000	24	-1.00	6.10	-7.0	0.0	4.0
6000	24	-2.33	6.26	-6.0	-4.0	2.0
M512	24	-0.83	3.52	-2.5	0.0	1.0
D4	24	-0.75	5.43	-5.5	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	24	0.67	5.23	-4.0	0.0	4.0
1000	24	1.08	3.73	-2.0	1.0	3.5
2000	24	-0.17	7.87	-4.0	0.0	5.5
4000	24	-0.25	8.97	-5.5	-1.0	6.0
6000	24	-0.75	8.46	-4.0	0.0	3.5
M512	24	0.46	3.24	-1.0	0.5	2.0

* $.01 < p \leq .05$

TABLE 49 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	22	0.91	6.81	-2.5	1.0	6.0
1000	23	1.48	5.33	-2.0	0.0	6.0
2000	23	1.13	5.75	-4.0	0.0	6.0
4000	23	0.87	8.50	-6.0	0.0	6.0
6000	23	2.26	9.27	-4.0	2.0	6.0
M512	22	1.14	4.51	-1.2	0.0	12.0
D4	23	0.61	8.28	-6.0	0.0	3.3
D1	23	-0.70	5.45	-4.0	0.0	8.0
					-2.0	2.0
LEFT EAR						
500	22	2.36	18.64	-6.0	0.0	10.5
1000	22	4.55	18.94	-4.5	0.0	11.5
2000	22	1.09	10.97	-6.5	-1.0	4.5
4000	22	2.55	11.99	-3.5	0.0	10.5
6000	22	1.45	13.37	-10.0	-1.0	12.0
M512	22	2.64	14.86	-5.3	0.0	6.0
D4	22	2.00	12.48	-8.5	0.0	10.0
D1	22	-1.82	8.28	-4.5	0.0	2.5
BETTER EAR						
500	22	0.91	7.63	-4.0	1.0	4.5
1000	23	1.30	6.51	-2.0	0.0	6.0
2000	23	-0.09	6.67	-4.0	2.0	4.0
4000	23	1.22	7.13	-6.0	0.0	8.0
6000	23	2.17	10.07	-6.0	2.0	8.0
M512	22	0.82	5.28	-3.3	0.5	4.3
D4	23	0.09	7.27	-6.0	0.0	8.0
WORSE EAR						
500	22	2.36	16.88	-4.5	-1.0	9.0
1000	22	4.73	17.83	-2.0	0.0	7.0
2000	22	1.73	8.84	-4.5	0.0	4.5
4000	22	2.18	10.47	-6.0	1.0	6.5
6000	22	1.45	11.53	-8.5	-1.0	7.5
M512	22	3.05	13.24	-3.3	0.0	5.0
D4	22	2.55	11.86	-4.5	1.0	8.5
LEFT-RIGHT DIFFERENCES						
500	22	1.45	18.07	-2.0	0.0	4.5
1000	22	2.91	19.56	-4.5	0.0	6.5
2000	22	0.09	11.01	-6.0	-1.0	3.0
4000	22	1.82	14.70	-6.0	-1.0	10.5
6000	22	-0.36	11.56	-7.0	0.0	6.5
M512	22	1.59	14.90	-2.0	0.0	4.5

TABLE 50 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	23	-1.30	5.80	-4.0	-2.0	0.0
1000	23	0.17	4.30	-2.0	0.0	2.0
2000	23	-2.17*	4.51	-4.0	-2.0	2.0
4000	23	-1.74	9.23	-10.0	-2.0	4.0
6000	23	-2.78	7.90	-8.0	-2.0	4.0
M512	23	-1.13	3.71	-3.0	-1.0	0.0
D4	23	1.91	7.80	-4.0	0.0	10.0
D1	23	-0.17	3.46	-2.0	0.0	2.0
LEFT EAR						
500	22	-0.36	7.50	-6.0	-1.0	2.5
1000	22	-1.73	6.66	-6.0	-3.0	1.0
2000	23	-0.52	6.88	-6.0	-2.0	2.0
4000	23	1.04	9.12	-6.0	2.0	4.0
6000	23	-0.96	8.20	-8.0	0.0	4.0
M512	22	-0.91	6.07	-4.0	-3.0	1.2
D4	22	-2.73	8.34	-7.0	-2.0	4.0
D1	22	0.64	4.07	-2.0	0.0	4.0
BETTER EAR						
500	23	-0.96	6.18	-6.0	-2.0	2.0
1000	23	-1.57	5.66	-6.0	-2.0	0.0
2000	23	-0.78	5.07	-4.0	0.0	2.0
4000	23	0.17	7.93	-4.0	0.0	4.0
6000	23	-2.17	6.26	-8.0	-2.0	2.0
M512	23	-1.17	5.01	-4.0	-2.0	2.0
D4	23	-1.74	6.30	-6.0	-2.0	0.0
WORSE EAR						
500	22	-0.64	6.72	-6.0	-1.0	4.0
1000	22	0.18	5.31	-4.0	0.0	2.5
2000	23	-1.91	6.16	-4.0	-2.0	2.0
4000	23	-0.87	9.14	-6.0	2.0	4.0
6000	23	-1.57	8.78	-8.0	0.0	4.0
M512	22	-0.73	4.84	-4.0	-1.0	0.2
D4	22	1.18	7.75	-4.0	0.0	5.0
LEFT-RIGHT DIFFERENCES						
500	22	1.00	4.73	-2.0	0.0	4.0
1000	22	-2.00	4.98	-5.0	-3.0	2.5
2000	23	1.65	6.97	-4.0	2.0	10.0
4000	23	2.78	8.28	-2.0	0.0	6.0
6000	23	1.83	8.44	-4.0	2.0	6.0
M512	22	0.18	3.19	-2.0	0.0	2.0

* $.01 < p \leq .05$

TABLE 51 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	36	-0.39	7.28	-6.0	0.0	4.0
1000	36	-1.22	5.84	-4.0	-2.0	2.0
2000	36	-1.72*	4.81	-6.0	-2.0	2.0
4000	36	-0.61	6.06	-6.0	0.0	3.5
6000	36	-0.33	9.09	-6.0	0.0	6.0
M512	36	-1.11	4.58	-4.8	-1.5	1.8
D4	36	-0.61	7.06	-6.0	0.0	4.0
D1	36	0.39	4.35	-2.0	0.0	3.5
LEFT EAR						
500	36	-1.89	9.10	-7.5	-3.0	4.0
1000	36	-1.56	8.70	-8.0	-1.0	5.5
2000	35	-1.37	5.63	-6.0	0.0	2.0
4000	36	0.06	9.24	-6.0	2.0	6.0
6000	36	-1.17	10.24	-7.5	-2.0	6.0
M512	35	-1.80	6.01	-6.0	-3.0	2.0
D4	36	-1.61	9.14	-8.0	-3.0	4.0
D1	36	0.06	5.27	-2.0	0.0	3.5
BETTER EAR						
500	36	-0.94	7.43	-6.0	-1.0	4.0
1000	36	-1.11	5.98	-6.0	-1.0	2.0
2000	36	-1.39	4.30	-4.0	0.0	2.0
4000	36	-0.06	6.56	-6.0	2.0	4.0
6000	36	-0.67	8.94	-8.0	0.0	5.5
M512	36	-1.14	4.55	-4.8	-0.5	2.0
D4	36	-1.06	7.27	-6.0	-2.0	4.0
WORSE EAR						
500	36	-1.33	8.24	-6.0	-3.0	4.0
1000	36	-1.67	8.22	-6.0	-4.0	4.0
2000	35	-1.77	5.63	-6.0	-2.0	2.0
4000	36	-0.50	8.03	-5.5	0.0	4.0
6000	36	-0.83	8.29	-4.0	-1.0	5.5
M512	35	-1.83	5.66	-5.0	-2.0	2.0
D4	36	-1.17	8.09	-8.0	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	36	-1.50	7.55	-5.5	-2.0	2.0
1000	36	-0.33	7.21	-4.0	0.0	5.5
2000	35	0.51	5.39	-2.0	2.0	6.0
4000	36	0.67	8.57	-4.0	0.0	6.0
6000	36	-0.83	10.86	-9.5	-1.0	6.0
M512	35	-0.86	4.85	-3.0	0.0	2.0

* $.01 < p \leq .05$

TABLE 52 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	-0.16	6.77	-5.0	0.0	4.0
1000	37	-1.03	6.10	-4.0	0.0	2.0
2000	37	-0.22	5.01	-4.0	0.0	4.0
4000	37	0.92	7.10	-3.0	0.0	5.0
6000	37	0.27	6.13	-2.0	0.0	4.0
M512	37	-0.35	4.04	-2.5	-1.0	2.5
D4	37	-1.95	9.32	-8.0	-2.0	4.0
D1	37	-0.11	3.62	-2.0	0.0	2.0
LEFT EAR						
500	37	-0.22	7.16	-4.0	0.0	4.0
1000	37	-0.43	7.27	-4.0	0.0	3.0
2000	37	0.27	5.19	-2.0	0.0	4.0
4000	37	0.76	7.46	-4.0	0.0	5.0
6000	37	1.03	7.21	-5.0	0.0	7.0
M512	37	-0.16	5.24	-3.5	1.0	3.0
D4	37	-1.19	8.05	-6.0	0.0	4.0
D1	37	-0.65	3.50	-2.0	0.0	1.0
BETTER EAR						
500	37	-0.05	7.34	-3.0	0.0	4.0
1000	37	-0.22	6.56	-2.0	0.0	2.0
2000	37	0.16	4.86	-2.0	0.0	4.0
4000	37	1.24	6.31	-1.0	0.0	5.0
6000	37	0.86	5.69	-2.0	0.0	6.0
M512	37	0.03	4.76	-3.5	0.0	3.0
D4	37	-1.46	7.11	-6.0	-2.0	4.0
WORSE EAR						
500	37	-0.32	5.26	-4.0	0.0	2.0
1000	37	-1.24	6.17	-5.0	0.0	3.0
2000	37	-0.11	5.01	-2.0	0.0	4.0
4000	37	0.43	6.78	-4.0	0.0	6.0
6000	37	0.43	6.45	-4.0	0.0	4.0
M512	37	-0.57	4.09	-3.5	-1.0	2.0
D4	37	-1.68	8.43	-7.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	37	-0.05	6.67	-4.0	0.0	4.0
1000	37	0.59	6.07	-2.0	0.0	4.0
2000	37	0.49	5.32	-3.0	0.0	4.0
4000	37	-0.16	8.26	-6.0	0.0	5.0
6000	37	0.76	8.62	-4.0	0.0	7.0
M512	37	0.38	3.29	-1.0	0.0	2.5

TABLE 53 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	49	-0.94	6.48	-5.0	0.0	4.0
1000	49	-1.84*	6.03	-4.0	0.0	2.0
2000	49	-1.76*	5.59	-6.0	-2.0	2.0
4000	49	-1.76	6.36	-6.0	0.0	2.0
6000	49	0.53	8.16	-5.0	0.0	6.0
M512	49	-1.33*	3.98	-3.5	0.0	1.0
D4	49	-0.08	7.66	-5.0	0.0	6.0
D1	49	0.29	3.61	-2.0	0.0	2.0
LEFT EAR						
500	49	-0.41	5.77	-4.0	0.0	4.0
1000	49	-0.73	5.24	-4.0	0.0	2.0
2000	49	-0.04	4.41	-3.0	0.0	4.0
4000	49	-1.06	6.52	-6.0	-2.0	4.0
6000	49	-0.61	8.76	-6.0	0.0	6.0
M512	49	-0.41	3.54	-3.0	0.0	2.0
D4	49	0.33	7.55	-4.0	2.0	6.0
D1	49	-0.20	4.03	-2.0	0.0	3.0
BETTER EAR						
500	49	-0.41	5.61	-4.0	0.0	4.0
1000	49	-1.10	4.92	-4.0	0.0	1.0
2000	49	-0.78	4.20	-4.0	0.0	2.0
4000	49	-0.78	5.47	-6.0	0.0	2.0
6000	49	0.86	7.36	-3.0	2.0	4.0
M512	49	-0.73	3.07	-3.0	-1.0	1.0
D4	49	-0.33	6.46	-4.0	0.0	3.0
WORSE EAR						
500	49	-0.94	6.07	-4.0	0.0	4.0
1000	49	-1.47	5.70	-4.0	0.0	2.0
2000	49	-1.02	4.71	-4.0	0.0	2.0
4000	49	-2.04*	5.58	-6.0	-2.0	2.0
6000	49	-0.94	7.77	-6.0	0.0	5.0
M512	49	-1.02	4.02	-4.0	0.0	2.0
D4	49	0.57	7.30	-4.0	0.0	6.0
LEFT-RIGHT DIFFERENCES						
500	49	0.53	5.18	-4.0	0.0	4.0
1000	49	1.10	6.21	-4.0	0.0	5.0
2000	49	1.71	6.26	-2.0	0.0	6.0
4000	49	0.69	8.13	-6.0	0.0	6.0
6000	49	-1.14	9.28	-7.0	0.0	4.0
M512	49	1.00*	3.32	-1.0	1.0	3.0

* $.01 < p \leq .05$

TABLE 54 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	51	-0.67	6.83	-6.0	0.0	4.0
1000	51	0.31	6.44	-4.0	0.0	4.0
2000	51	0.27	5.09	-2.0	0.0	4.0
4000	51	-0.31	5.92	-4.0	0.0	2.0
6000	51	-0.55	6.08	-6.0	0.0	2.0
M512	51	-0.02	4.26	-3.0	0.0	4.0
D4	51	0.63	6.91	-2.0	0.0	3.0
D1	51	0.04	5.13	-2.0	0.0	4.0
LEFT EAR						
500	51	-0.86	6.70	-4.0	-2.0	4.0
1000	51	0.47	6.42	-4.0	0.0	4.0
2000	51	0.47	5.95	-4.0	0.0	4.0
4000	51	-0.59	6.91	-4.0	0.0	4.0
6000	51	0.55	8.11	-4.0	0.0	6.0
M512	51	0.14	4.80	-3.0	0.0	3.0
D4	51	1.06	8.55	-4.0	0.0	4.0
D1	51	0.04	3.11	-2.0	0.0	2.0
BETTER EAR						
500	51	-1.02	6.19	-4.0	0.0	2.0
1000	51	-0.35	6.53	-4.0	0.0	2.0
2000	51	-0.12	4.16	-2.0	0.0	2.0
4000	51	-0.08	6.26	-4.0	0.0	4.0
6000	51	-0.39	6.27	-6.0	0.0	4.0
M512	51	-0.49	4.05	-3.0	-1.0	2.0
D4	51	-0.27	7.82	-6.0	0.0	4.0
WORSE EAR						
500	51	-0.51	5.92	-4.0	0.0	4.0
1000	51	1.14	5.80	-2.0	0.0	4.0
2000	51	0.86	5.30	-2.0	0.0	2.0
4000	51	-0.82	5.98	-6.0	0.0	2.0
6000	51	0.39	6.93	-4.0	0.0	6.0
M512	51	0.45	4.42	-2.0	0.0	3.0
D4	51	1.96	7.06	-4.0	2.0	6.0
LEFT-RIGHT DIFFERENCES						
500	51	-0.20	7.45	-4.0	0.0	4.0
1000	51	0.16	5.71	-4.0	0.0	4.0
2000	51	0.20	8.74	-4.0	-2.0	6.0
4000	51	-0.27	6.71	-6.0	-2.0	6.0
6000	51	1.10	7.97	-6.0	2.0	8.0
M512	51	0.06	3.98	-2.0	0.0	2.0

TABLE 55 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	53	-0.53	7.11	-6.0	0.0	6.0
1000	53	-0.19	5.93	-4.0	0.0	3.0
2000	53	0.34	4.65	-4.0	0.0	4.0
4000	53	-0.49	7.17	-6.0	0.0	3.0
6000	53	-0.34	8.49	-6.0	0.0	6.0
M512	53	-0.15	4.11	-3.0	0.0	2.0
D4	53	0.30	8.31	-6.0	0.0	7.0
D1	53	-0.57	3.73	-2.0	0.0	2.0
LEFT EAR						
500	53	-1.02	5.76	-6.0	0.0	3.0
1000	53	0.34	4.94	-4.0	0.0	4.0
2000	53	0.60	3.73	-2.0	0.0	3.0
4000	53	-1.32	7.51	-5.0	0.0	4.0
6000	53	0.13	9.70	-6.0	0.0	6.0
M512	53	-0.09	3.83	-3.0	0.0	3.0
D4	53	1.66	8.44	-4.0	2.0	7.0
D1	53	0.04	3.77	-2.0	0.0	2.0
BETTER EAR						
500	53	-1.02	5.17	-6.0	0.0	3.0
1000	53	0.23	4.20	-2.0	0.0	3.0
2000	53	0.45	3.57	-2.0	0.0	2.0
4000	53	-0.42	6.78	-5.0	0.0	4.0
6000	53	0.42	8.46	-6.0	0.0	8.0
M512	53	-0.11	3.57	-2.5	0.0	2.0
D4	53	0.64	6.58	-4.0	0.0	4.0
WORSE EAR						
500	53	-0.53	6.74	-4.0	0.0	6.0
1000	53	-0.08	5.05	-4.0	0.0	2.0
2000	53	0.49	4.09	-3.0	0.0	4.0
4000	53	-1.40	7.32	-4.0	0.0	2.0
6000	53	-0.62	8.88	-8.0	0.0	6.0
M512	53	-0.04	3.85	-3.0	0.0	2.0
D4	53	1.32	7.64	-4.0	0.0	7.0
LEFT-RIGHT DIFFERENCES						
500	53	-0.49	6.11	-4.0	0.0	4.0
1000	53	0.53	7.61	-4.0	0.0	5.0
2000	53	0.26	5.25	-4.0	0.0	4.0
4000	53	-0.83	8.14	-6.0	0.0	6.0
6000	53	0.47	8.32	-8.0	0.0	6.0
M512	53	0.06	3.70	-2.0	0.0	2.0

TABLE 56 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	49	0.20	5.26	-4.0	0.0	4.0
1000	49	-0.16	6.01	-4.0	0.0	4.0
2000	49	0.24	5.13	-2.0	0.0	4.0
4000	49	-0.37	6.24	-4.0	0.0	4.0
6000	49	1.02	6.62	-4.0	0.0	6.0
M512	49	0.06	3.63	-2.0	0.0	3.5
D4	49	0.20	6.65	-6.0	0.0	6.0
D1	49	0.24	4.43	-3.0	0.0	4.0
LEFT EAR						
500	49	-0.49	6.23	-4.0	0.0	4.0
1000	49	0.04	6.76	-6.0	0.0	4.0
2000	49	0.69	5.25	-2.0	0.0	4.0
4000	49	0.33	7.22	-6.0	2.0	4.0
6000	49	0.37	8.08	-4.0	0.0	6.0
M512	49	0.02	4.66	-3.5	0.0	6.0
D4	49	-0.29	7.38	-6.0	0.0	2.0
D1	49	0.16	4.34	-2.0	0.0	4.0
BETTER EAR						
500	49	0.08	5.37	-4.0	0.0	4.0
1000	49	0.57	6.08	-4.0	0.0	3.0
2000	49	0.86	4.40	-2.0	0.0	4.0
4000	49	-0.41	5.52	-4.0	0.0	3.0
6000	49	0.86	6.24	-3.0	2.0	6.0
M512	49	0.49	4.14	-2.0	0.0	3.0
D4	49	0.98	6.43	-2.0	2.0	4.0
WORSE EAR						
500	49	-0.37	5.46	-4.0	-2.0	4.0
1000	49	-0.69	5.82	-4.0	-2.0	4.0
2000	49	0.08	4.98	-2.0	0.0	4.0
4000	49	0.37	6.41	-4.0	0.0	4.0
6000	49	0.53	7.27	-6.0	0.0	4.0
M512	49	-0.33	3.63	-2.5	0.0	6.0
D4	49	-1.06	6.10	-6.0	-2.0	1.0
LEFT-RIGHT DIFFERENCES						
500	49	-0.69	6.13	-6.0	-2.0	5.0
1000	49	0.20	6.52	-4.0	0.0	4.0
2000	49	0.45	6.75	-4.0	0.0	4.0
4000	49	0.69	8.43	-6.0	0.0	8.0
6000	49	-0.65	9.35	-8.0	-2.0	6.0
M512	49	-0.06	3.67	-3.0	-1.0	2.5

TABLE 57 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	47	-1.23	4.65	-4.0	-2.0	2.0
1000	47	-1.32	5.30	-4.0	0.0	2.0
2000	47	-1.66*	4.50	-4.0	0.0	0.0
4000	47	-2.49**	5.50	-6.0	-2.0	0.0
6000	47	-2.38*	7.39	-6.0	0.0	2.0
M512	47	-1.32**	3.32	-4.0	-1.0	1.0
D4	47	1.17	7.19	-2.0	2.0	6.0
D1	47	0.85	4.19	-2.0	0.0	4.0
LEFT EAR						
500	47	-0.85	5.00	-4.0	0.0	4.0
1000	47	-1.49*	4.62	-4.0	0.0	2.0
2000	47	-1.23	4.64	-6.0	0.0	2.0
4000	47	-0.30	9.08	-6.0	0.0	4.0
6000	47	-1.79	6.24	-6.0	-2.0	2.0
M512	47	-1.09	3.84	-5.0	-1.0	2.0
D4	47	-1.19	10.19	-6.0	2.0	4.0
D1	47	-0.21	3.42	-2.0	0.0	2.0
BETTER EAR						
500	47	-1.23	4.36	-4.0	0.0	0.0
1000	47	-1.36*	3.76	-4.0	0.0	2.0
2000	47	-1.40*	3.87	-2.0	0.0	0.0
4000	47	-1.60*	5.16	-4.0	0.0	0.0
6000	47	-2.30**	5.64	-6.0	-2.0	0.0
M512	47	-1.23*	3.20	-3.0	-1.0	1.0
D4	47	0.23	5.73	-2.0	2.0	4.0
WORSE EAR						
500	47	-0.85	4.56	-4.0	0.0	2.0
1000	47	-1.45	5.14	-6.0	-2.0	2.0
2000	47	-1.49*	4.50	-6.0	0.0	2.0
4000	47	-1.19	8.83	-6.0	-2.0	2.0
6000	47	-1.87	6.93	-6.0	0.0	2.0
M512	47	-1.15*	3.53	-4.0	-1.0	2.0
D4	47	-0.26	9.41	-6.0	2.0	6.0
LEFT-RIGHT DIFFERENCES						
500	47	0.38	5.50	-2.0	0.0	4.0
1000	47	-0.17	5.92	-6.0	-2.0	4.0
2000	47	0.43	6.41	-4.0	0.0	4.0
4000	47	2.19	9.87	-4.0	2.0	8.0
6000	47	0.60	8.65	-6.0	0.0	6.0
M512	47	0.15	3.96	-1.0	0.0	3.0

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 58 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF BOYS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	32	-1.69	6.33	-5.5	-1.0	2.0
1000	32	-1.44	5.66	-5.5	-1.0	2.0
2000	32	-0.81	4.06	-4.0	-1.0	2.0
4000	32	-2.19*	5.60	-6.0	-1.0	2.0
6000	32	-3.56**	6.85	-8.0	-3.0	0.0
M512	32	-1.16	3.73	-3.7	-1.5	1.0
D4	32	0.75	6.96	-4.0	1.0	6.0
D1	32	0.56	4.01	-2.0	0.0	2.0
LEFT EAR						
500	32	-0.56	4.32	-4.0	0.0	2.0
1000	32	-1.13	4.54	-4.0	-2.0	2.0
2000	32	-0.75	6.92	-4.0	-2.0	3.5
4000	32	-1.94	8.42	-6.0	0.0	4.0
6000	32	-2.25	10.63	-10.0	-3.0	4.0
M512	32	-0.72	4.11	-3.0	-1.0	1.8
D4	32	0.81	7.62	-4.0	0.0	5.5
D1	32	-1.31	4.27	-4.0	-2.0	2.0
BETTER EAR						
500	32	-1.25	4.30	-4.0	-1.0	2.0
1000	32	-1.44	5.21	-5.5	-2.0	1.5
2000	32	-0.94	4.60	-4.0	0.0	2.0
4000	32	-2.25	6.73	-7.5	-1.0	2.0
6000	32	-2.31	7.28	-7.5	-2.0	2.0
M512	32	-1.22	3.68	-4.0	-1.0	1.8
D4	32	0.81	7.46	-4.0	0.0	6.0
WORSE EAR						
500	32	-1.00	4.95	-4.0	0.0	2.0
1000	32	-1.13	4.00	-4.0	-2.0	2.0
2000	32	-0.62	4.96	-4.0	-1.0	2.0
4000	32	-1.87	6.30	-6.0	-2.0	2.0
6000	32	-3.50*	9.00	-10.0	-4.0	1.5
M512	32	-0.72	3.01	-2.0	-1.0	1.0
D4	32	0.75	6.05	-4.0	2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	32	1.13	6.56	-3.5	0.0	5.0
1000	32	0.31	5.97	-4.0	0.0	4.0
2000	32	0.06	7.94	-5.5	0.0	2.0
4000	32	0.25	8.44	-6.0	0.0	7.5
6000	32	1.31	11.94	-7.5	0.0	10.0
M512	32	0.50	4.56	-2.0	0.0	2.0

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 59 - DESCRIPTIVE STATISTICS OF SIX-MONTH INCREMENTS IN AUDITORY THRESHOLD OF GIRLS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	20	-2.30*	4.32	-4.0	-2.0	0.0
1000	20	-0.20	4.85	-4.0	0.0	3.5
2000	20	-2.60	6.16	-7.0	-2.0	1.5
4000	20	-4.00*	7.62	-8.0	-4.0	2.0
6000	20	-1.30	8.24	-6.0	2.0	4.0
M512	20	-1.75	3.89	-5.8	-1.5	1.0
D4	20	3.80*	7.02	0.0	4.0	6.0
D1	20	-0.70	4.65	-4.0	0.0	2.0
LEFT EAR						
500	20	-1.00	6.07	-4.0	0.0	2.0
1000	20	-0.90	4.70	-4.0	0.0	2.0
2000	20	-1.60	5.53	-5.5	-2.0	2.0
4000	20	-0.50	6.08	-2.0	0.0	4.0
6000	20	-1.20	8.04	-5.5	-1.0	3.5
M512	20	-1.15	4.48	-4.5	-1.0	2.0
D4	20	-0.40	6.82	-5.0	0.0	2.0
D1	20	0.50	3.24	-2.0	0.0	2.0
BETTER EAR						
500	20	-1.00	5.68	-4.0	0.0	2.0
1000	20	-0.70	4.78	-4.0	0.0	2.0
2000	20	-1.00	5.56	-4.0	0.0	2.0
4000	20	-2.30	5.85	-6.0	0.0	2.0
6000	20	-0.20	7.51	-3.5	0.0	4.0
M512	20	-0.85	4.57	-4.5	0.0	2.8
D4	20	1.60	5.97	0.0	0.0	4.0
WORSE EAR						
500	20	-2.30*	4.37	-4.0	-2.0	1.5
1000	20	-0.40	4.33	-4.0	0.0	2.0
2000	20	-3.20**	5.00	-7.0	-4.0	-0.5
4000	20	-2.20	6.68	-7.5	0.0	3.5
6000	20	-2.30	7.49	-9.0	-2.0	1.5
M512	20	-1.85*	3.27	-3.7	-2.0	0.7
D4	20	1.80	6.29	0.0	1.0	3.5
LEFT-RIGHT DIFFERENCES						
500	20	1.30	5.44	-4.0	0.0	5.5
1000	20	-0.70	5.20	-4.0	-1.0	2.0
2000	20	1.00	9.17	-2.0	2.0	6.0
4000	20	3.50	7.78	-2.0	4.0	8.0
6000	20	0.10	11.15	-9.5	-1.0	9.0
M512	20	0.50	4.49	-1.0	0.0	2.8

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 60 -SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN AGE AND 6- MONTH AUDITORY THRESHOLD INCREMENTS IN BOYS AND GIRLS

Frequency (Hz)	n	Boys Correlation Coefficients	n	Girls Correlation Coefficients
Right ear				
500	360	0.03	353	-0.04
1000	361	-0.03	358	-0.04
2000	363	-0.02	359	-0.05
4000	363	-0.03	357	-0.08
6000	363	-0.01	356	0.04
M512	360	0.00	353	-0.07
D4	361	-0.00	356	0.05
Left ear				
500	348	-0.00	341	-0.02
1000	354	-0.05	345	-0.04
2000	360	-0.04	346	-0.06
4000	357	-0.02	344	-0.02
6000	354	0.03	344	-0.04
M512	348	-0.03	341	-0.06
D4	354	-0.04	342	-0.02
Better Ear				
500	363	0.01	353	-0.02
1000	363	-0.04	358	-0.02
2000	363	0.00	359	-0.02
4000	363	0.00	357	-0.04
6000	363	0.06	356	0.05
M512	363	-0.01	353	-0.05
D4	363	-0.02	356	0.02
Worse Ear				
500	345	0.03	341	-0.03
1000	352	-0.06	345	-0.06
2000	360	-0.05	346	-0.07
4000	357	-0.05	344	-0.06
6000	354	-0.01	344	-0.05
M512	345	0.01	340	-0.07
D4	352	0.00	342	0.01

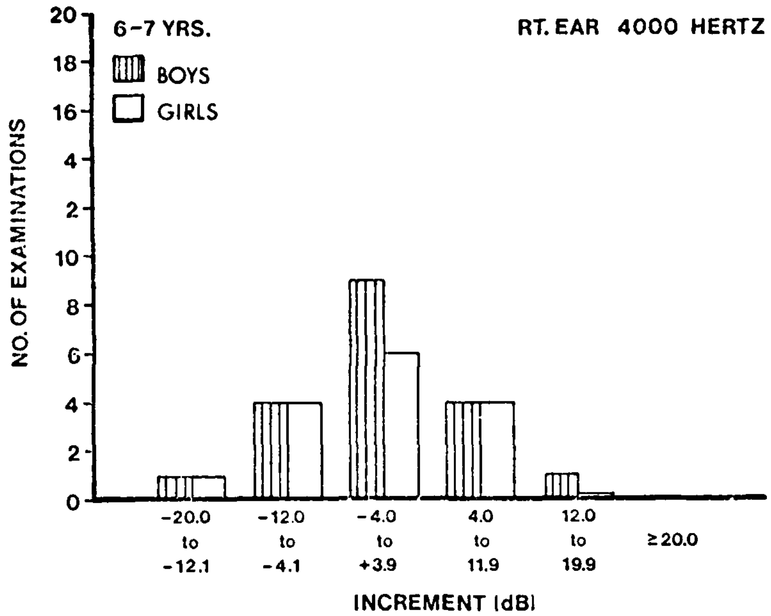

FIGURE 38 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 6-7 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

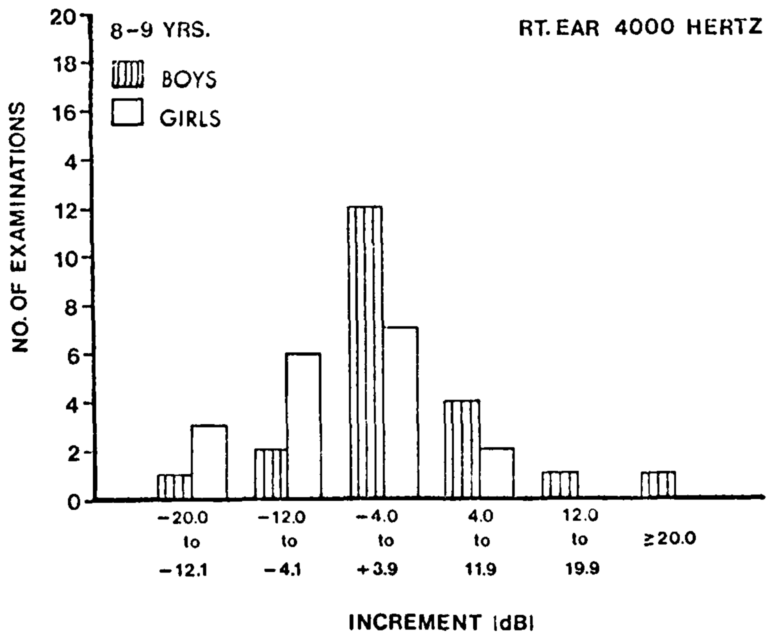

FIGURE 39 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 8-9 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

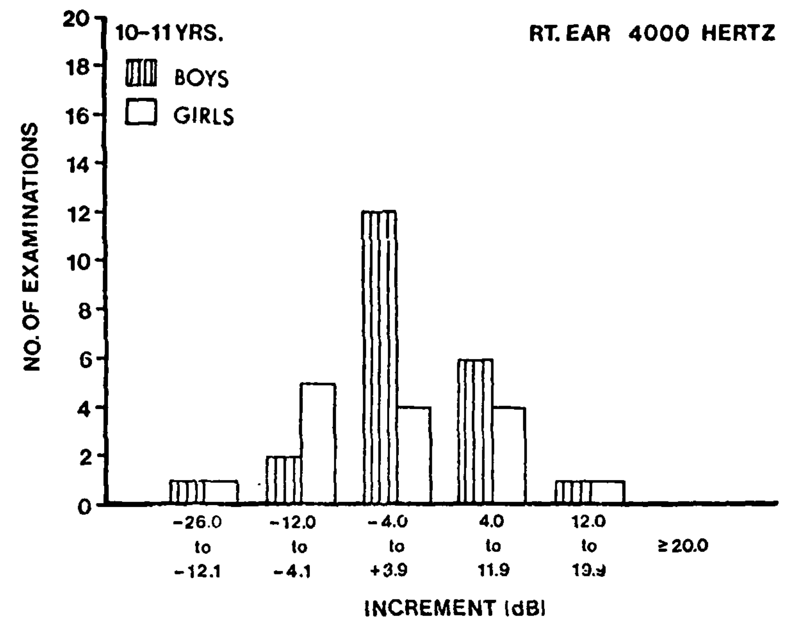

FIGURE 40 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 10-11 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

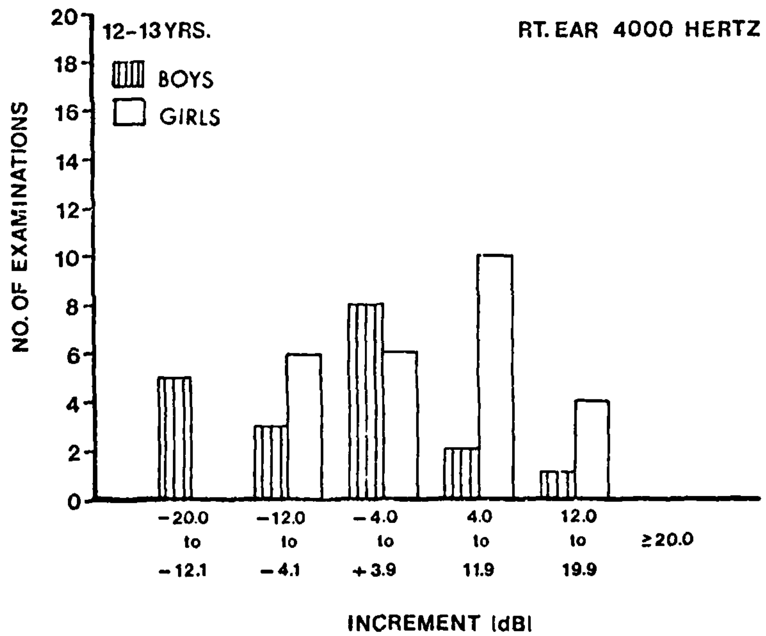

FIGURE 41 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 12-13 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

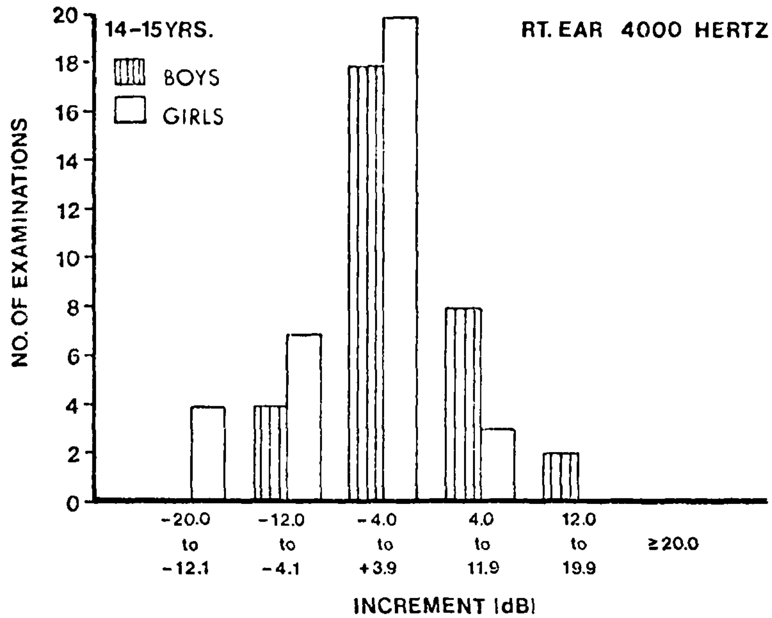

FIGURE 42 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 14-15 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

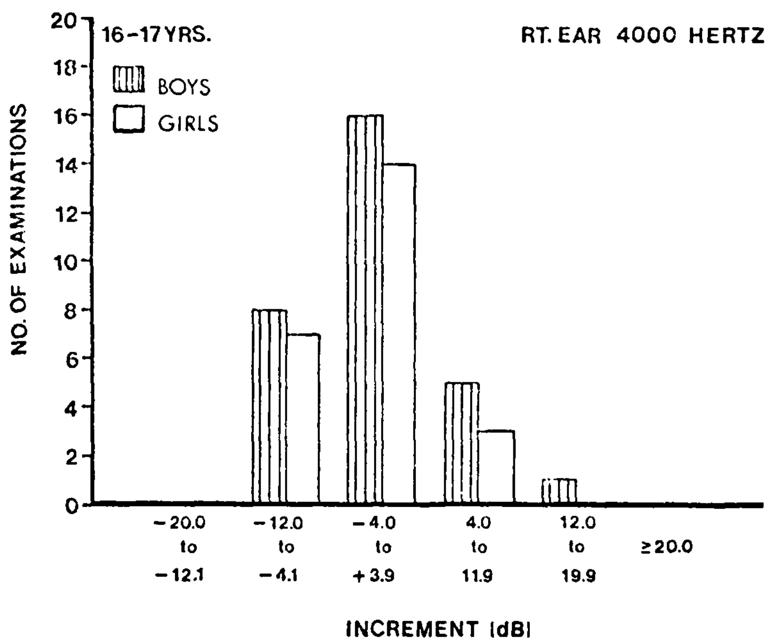

FIGURE 43 -FREQUENCY DISTRIBUTION OF SIX-MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 16-17 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR

The apparent tendency for the left ear to hear better than the right may be an artifact of our testing procedure. As the right ear is always tested first, better performance due to practice and familiarity with the tone might be expected for the left ear.

The lateral differences seen in the mean auditory thresholds are not present in the mean increments (Tables 36 through 59). Only two lateral differences in increments are significant, no more than expected by chance.

NOISE EXPOSURE

At each examination a detailed questionnaire was completed regarding noise exposure. Different questionnaires were administered on the first examination and on subsequent examinations (Roche et al., 1976). The responses to the noise exposure questions were weighted differentially to allow a quantitative noise assessment for each question. The individual question scores were then summed to provide a single total noise score. Three other scores were derived (chain saw, gun, and event) to evaluate particular events that might be important in a participant's noise exposure. The scoring systems that are used have been described previously (Roche et al., 1977).

Noise exposure is considered separately for the questionnaires taken on the first visit, representing the total previous noise exposure history; and questionnaires completed on subsequent six-monthly visits, representing noise exposure for the appropriate preceding interval. The major differences between the total noise exposure history and the interval noise exposure history are in the phraseology of the questions regarding the time periods of noise exposure. The various noise exposure scores were, with few exceptions, calculated in an identical manner for the total noise exposure histories and the interval noise exposure histories.

The summary statistics, including the ranges of scores for each noise-related question, and the derived scores from noise history questionnaires, are given in Table 61 for boys and girls. With few exceptions, the distributions of the scores are significantly skewed, being truncated at zero. This, of course, is why the means and medians are not coincident, and why many of the medians are zero. For data of this nature, only non-parametric statistical approaches are appropriate. There are no apparent sex differences in median scores. In most cases there is little difference between the maximum score for any item for girls compared to that for boys. Boys do have a notably higher maximum score for the gun question (No. 18), compared to that of the girls. However, the derived gun score, calculated differently from that of question 18, indicates that girls and boys had the same maximum. However, the mean for the boys (30.8) is considerably greater than that for the girls (12.6). The maximum total score is markedly greater in boys than girls. although the means and medians show only small sex differences.

TABLE 61 -NOISE HISTORY SCORES FOR CHILDREN 6-17 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
		BOYS			
(9)home	0.1	0.4	0.0	0.0	2.0
(10)T.V.	0.2	0.7	0.0	0.0	4.0
(11)stereo	1.7	1.6	1.6	0.0	6.6
(12)instrument	0.7	1.3	0.0	0.0	7.0
(13)live rock	0.0	0.2	0.0	0.0	2.0
(15)motor bikes	1.8	2.2	2.0	0.0	10.0
(16)eng/firewks.	2.1	16.7	0.0	0.0	190.0
(18)guns	0.2	1.8	0.0	0.0	20.5
(23)tools	3.2	2.8	3.3	0.0	10.0
(24)machinery	0.6	1.2	0.0	0.0	4.0
Chain saw	0.9	2.8	0.0	0.0	10.0
Gun	30.8	46.1	0.0	0.0	100.0
Event	3.4	1.6	3.0	0.0	7.0
Total	12.0	18.7	10.0	0.0	212.0
		GIRLS			
(9)home	0.2	0.6	0.0	0.0	2.0
(10)T.V.	0.0	0.2	0.0	0.0	1.2
(11)stereo	1.6	1.4	1.5	0.0	8.0
(12)instrument	0.7	1.2	0.0	0.0	5.3
(13)live rock	0.0	0.3	0.0	0.0	3.2
(15)motor bikes	1.7	2.0	0.0	0.0	10.0
(16)eng/fire wks.	0.0	0.4	0.0	0.0	3.6
(18)guns	0.0	0.0	0.0	0.0	0.0
(23)tools	2.3	1.9	1.7	0.0	6.7
(24)machinery	0.4	1.0	0.0	0.0	4.0
Chain saw	0.8	2.8	0.0	0.0	10.0
Gun	12.6	33.3	0.0	0.0	100.0
Event	3.1	1.6	3.0	0.0	8.0
Total	8.1	5.0	7.3	0.0	25.7

Based on data from appoximately 136 boys and 121 girls.

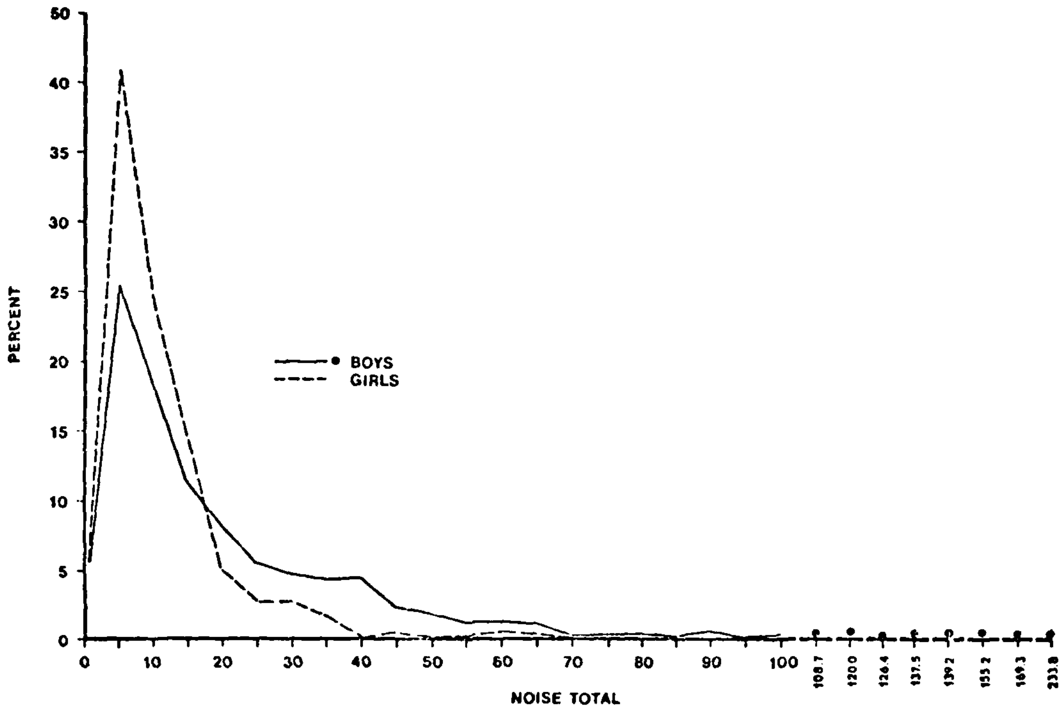

FIGURE 44 -PERCENTAGE DISTRIBUTIONS OF TOTAL NOISE SCORES FOR ALL EXAMINATIONS OF BOYS AND GIRLS FROM TOTAL NOISE EXPOSURE HISTORIES

The summary statistics for the scores from the interval noise exposure histories are given for 6 to 11 and 12 to 17 year old boys and girls in Tables 62 and 63. The ranges of scores for interval noise exposure are generally greater than the corresponding scores from the total noise exposure histories, although the general pattern of scores is similar in both noise exposure histories. Sex differences are most clearly seen in both age groups in the maximum scores for each item; the boys generally having higher maximum scores than the girls, especially for questions 16 (fireworks) and 23 (power tools), and the chain saw and gun scores. Exceptions to this pattern are the maximum scores for question 12, concerning playing an instrument.

Percentiles for total noise scores in boys and girls from the total noise histories are given in Table 64 and for the interval noise histories in Table 65; the latter is broken down by age groups.

The total noise scores obtained from the interval noise exposure histories are compared for boys and girls in Figure 44. The similarly skewed character of the two curves can be seen, although the greater range of the noise scores for the boys is evident.

TABLE 62 - INTERVAL NOISE SCORES FOR CHILDREN 6-11 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
	BOYS				
(9) home	0.0	0.2	0.0	0.0	2.0
(10) T.V.	1.0	1.3	0.7	0.0	9.0
(11) stereo	2.2	1.5	2.3	0.0	9.2
(12) instrument	0.1	0.3	0.0	0.0	2.5
(13) live rock	0.0	0.0	0.0	0.0	0.0
(15) motor bikes	1.0	1.5	0.0	0.0	6.0
(16) eng/fire wks.	1.6	7.8	0.0	0.0	90.0
(18) guns	2.3	6.2	0.0	0.0	47.5
(23) tools	2.3	6.6	0.0	0.0	63.3
(24) machinery	0.2	0.6	0.0	0.0	3.0
Chain saw	0.2	1.0	0.0	0.0	10.0
Gun	0.6	7.2	0.0	0.0	100.0
Event	2.0	1.5	2.0	0.0	7.0
Total	13.0	14.6	7.5	0.0	108.7
	GIRLS				
(9) home	0.0	0.2	0.0	0.0	2.0
(10) T.V.	0.9	1.2	0.5	0.0	6.0
(11) stereo	2.0	1.4	2.3	0.0	5.3
(12) instrument	0.4	1.6	0.0	0.0	18.0
(13) live rock	0.0	0.0	0.0	0.0	0.4
(15) motor bikes	0.6	1.0	0.0	0.0	3.0
(16) eng/fire wks.	0.7	3.6	0.0	0.0	30.0
(18) guns	0.3	1.8	0.0	0.0	14.8
(23) tools	0.8	1.9	0.0	0.0	11.7
(24) machinery	0.1	0.4	0.0	0.0	3.0
Chain saw	0.1	0.6	0.0	0.0	7.8
Gun	0.0	0.0	0.0	0.0	0.0
Event	1.6	1.2	2.0	0.0	5.0
Total	8.2	6.4	6.6	0.0	36.6

Based on data from approximately 207 boys and 169 girls.

TABLE 63 - INTERVAL NOISE SCORES FOR CHILDREN 12-17 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
	BOYS				
(9) home	0.0	0.1	0.0	0.0	1.0
(10) T.V.	0.8	1.1	0.5	0.0	9.0
(11) stereo	3.2	1.6	3.1	0.0	8.5
(12) instrument	3.2	1.6	3.1	0.0	8.5
(13) live rock	0.0	0.3	0.0	0.0	2.8
(15) motor bikes	1.3	1.9	0.0	0.0	10.0
(16) eng/fire wks.	6.3	20.9	0.0	0.0	210.0
(18) guns	3.1	7.6	0.0	0.0	54.0
(23) tools	10.1	15.9	4.7	0.0	113.7
(24) machinery	0.4	1.0	0.0	0.0	4.0
Chain saw	0.7	2.8	0.0	0.0	20.0
Gun	4.1	20.3	0.0	0.0	130.0
Event	2.7	1.5	3.0	0.0	7.0
Total	27.4	29.0	17.9	0.0	233.8
	GIRLS				
(9) home	0.0	0.1	0.0	0.0	2.0
(10) T.V.	0.8	0.9	0.5	0.0	6.0
(11) stereo	3.0	1.3	2.8	0.0	6.6
(12) instrument	1.3	2.0	0.4	0.0	14.0
(13) live rock	0.0	0.1	0.0	0.0	1.6
(15) motor bikes	1.0	1.7	0.0	0.0	8.0
(16) eng/fire wks.	1.1	7.4	0.0	0.0	110.0
(18) guns	0.8	4.1	0.0	0.0	47.2
(23) tools	2.9	5.9	0.0	0.0	40.0
(24) machinery	0.2	0.7	0.0	0.0	4.0
Chain saw	0.2	1.3	0.0	0.0	11.8
Gun	0.7	8.2	0.0	0.0	103.0
Event	1.8	1.5	2.0	0.0	7.0
Total	12.9	11.6	9.8	0.0	115.3

Based on data from approximately 288 boys and 309 girls

TABLE 64 - PERCENTILES FOR TOTAL NOISE SCORES FROM TOTAL NOISE EXPOSURE HISTORIES OF BOYS AND GIRLS 6-17 YEARS OF AGE

	Percentiles				
Questionnaire	10	25	50	75	90
Boys (n=136)	1.9	5.3	10.0	15.1	21.0
Girls (n=121)	2.2	4.9	7.3	10.7	15.1

TABLE 65 - PERCENTILES FOR TOTAL NOISE SCORES FROM INTERVAL NOISE EXPOSURE HISTORIES OF BOYS AND GIRLS 6-17 YEARS OF AGE

		Percentiles				
	N	10	25	50	75	90
Boys						
6-7 years	61	1.5	3.4	5.6	10.7	19.9
8-9 years	76	2.3	4.4	7.3	14.1	28.7
10-11 years	70	3.8	7.0	12.3	22.0	44.7
12-13 years	67	4.6	8.4	14.2	26.4	41.2
14-15 years	112	5.1	8.6	16.1	37.4	53.6
16-17 years	109	5.3	12.3	25.8	41.9	66.4
Girls						
6-7 years	52	0.6	2.5	5.3	9.9	16.8
8-9 years	61	2.8	4.3	6.8	10.3	15.1
10-11 years	56	3.5	5.8	7.3	12.0	19.5
12-13 years	80	3.7	6.4	10.1	14.2	26.6
14-15 years	136	4.1	6.6	10.5	17.3	30.7
16-17 years	93	3.2	4.5	8.6	15.1	22.0

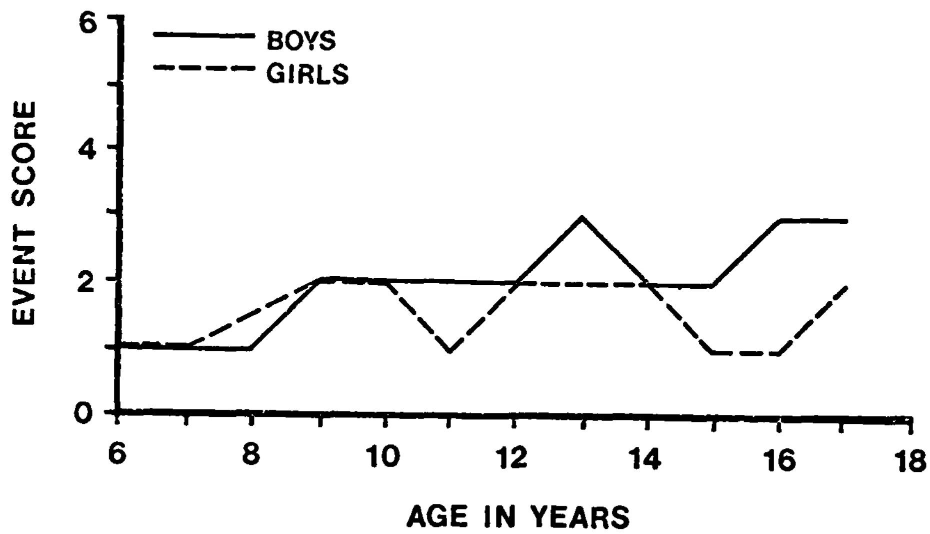

FIGURE 45 -MEDIAN EVENT SCORES FROM INTERVAL NOISE EXPOSURE HISTORIES FOR BOYS AND GIRLS

The extreme points for the interval noise exposure scores represent boys with unusually high scores. These extreme scores result primarily from exploding a large number of firecrackers (question 16), or noise exposure from operating, or being near, power tools (question 23), particularly gasoline lawn mowers.

The event score was devised in an attempt to quantify noise exposure through identifying the number of different types of events that may be important sources of noise exposure for a child. As shown in Tables 61 through 63, there is little difference between boys and girls in the number of important noise events experienced. The interval data show higher total event scores for boys after 14 years. This can be seen in Figure 45 which presents median event scores obtained from interval noise exposure histories at each age for boys and girls.

Although there appear to be neither systematic sex differences nor age trends in median event scores from the interval noise exposure histories in the preadolescent years, there seems to be a small, but definite, sex difference beginning by the age of 10 years; after this age, boys have consistently higher median event scores than girls.

The total noise scores and the total event scores are imprecise and susceptible to large errors in estimating the sound levels resulting from various activities. One person's exposure

to a "loud stereo" or "loud vehicle" may be 10, 20 or more dB higher than that of another person giving the same response to the question. For this reason, an alternative method of analysis was devised. Information contained in the questionnaire was used to group participants into those reporting exposure to a particular category of noise and those who were not exposed to that noise. The means and medians of each group were compared. The nine categories selected are the components of the total event score. While these categories are arbitrary, they are considered to be the most likely sources of noise exposure; these are summarized below:

Flight Pattern - Participant lives within 100 feet of a high traffic road or under an airport flight pattern.

Loud TV - Participant considers the TV is usually loud when he or she watches it.

Loud Music - Participant considers the volume of a radio or stereo system is loud, as opposed to medium or quiet, when he or she is listening to it.

Amplified Musical Instrument - Participant plays an amplified musical instrument.

Loud Vehicles - Participant is often near or involved with motorcycling, motorboating, drag or auto racing, go-carting, minibiking, etc.

Fireworks - Participant had been within 50 feet of exploding firecrackers or small gas engines.

Power Tools - Participants were near others using power tools, such as drills, saws, gasoline lawn mowers, etc.

Farm Machinery - Participants used or were often near farm machinery.

The percentage of boys and girls 6-to-11 or 12-to 17-years-old who reported exposure to the various noise source categories are summarized in Figures 46 and 47, respectively. For most noise categories, a slightly higher percentage of children in the 12-17 year age group reported exposure than in the younger age group. However, there is very little difference between the two age groups in the proportion exposed to any noise category. The only exceptions were loud TV in girls, in which a larger proportion of younger girls were exposed, and farm machinery in which a larger proportion of young boys reported exposure. Another noise event more frequent in younger children is riding a bus to school (not in Figures). Sixty-nine percent of boys and 67 percent of girls 6 to 11 years old ride buses, while 49 percent of boys and 54 percent of girls in the older age group ride school buses.

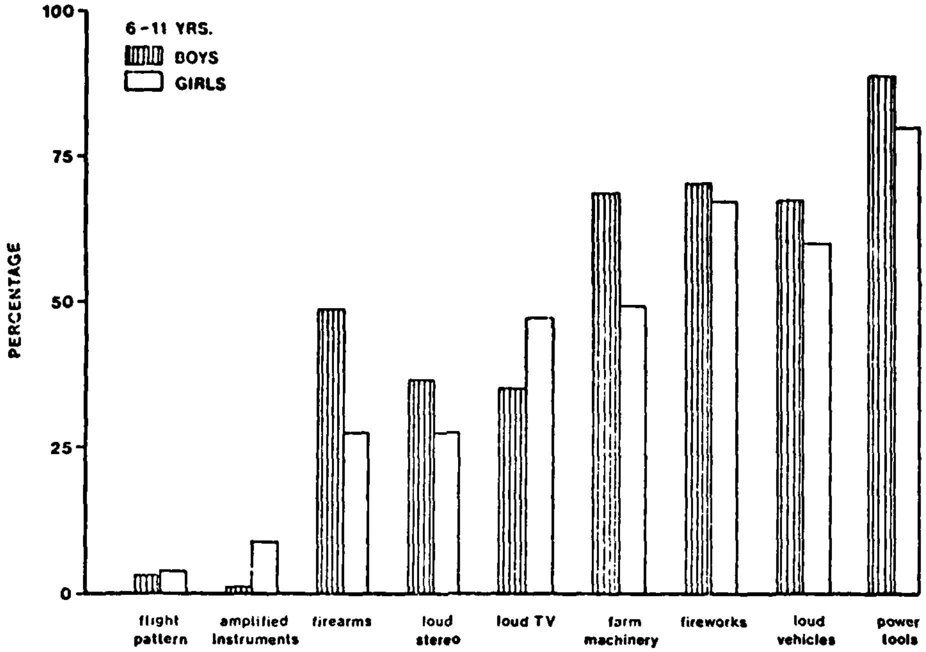

FIGURE 46 -PROPORTION OF BOYS AND GIRLS 6-11 YEARS OLD REPORTING EXPOSURE TO SPECIFIC NOISE EVENTS

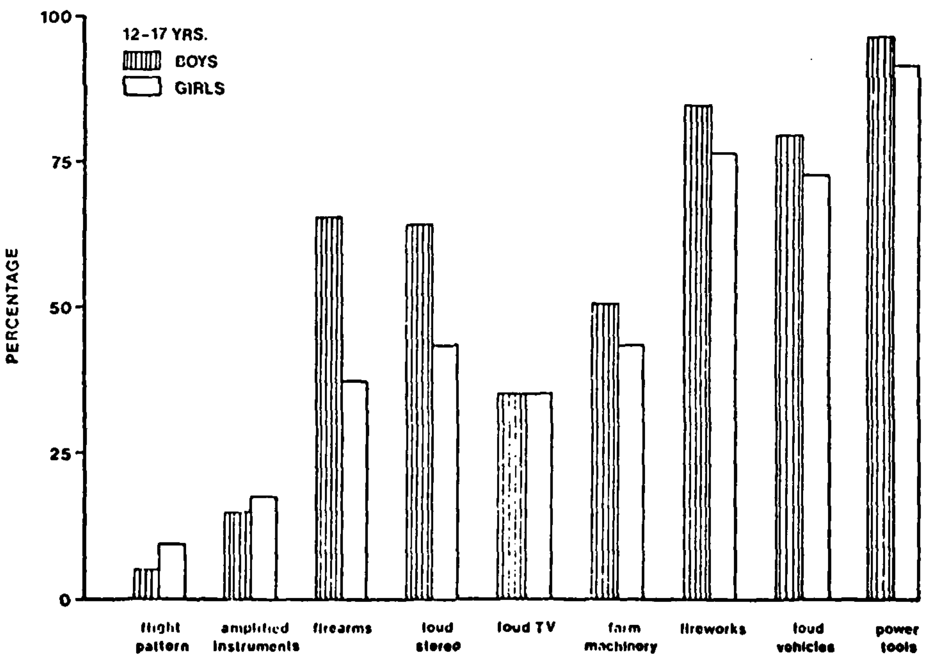

FIGURE 47 -PROPORTION OF BOYS AND GIRLS 12-17 YEARS OLD REPORTING EXPOSURE TO SPECIFIC NOISE EVENTS

TABLE 66 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN AGE AND NOISE SCORES

Noise Scores		Boys		Girls	
Period	Type	n	r	n	r
Total	Total	130	0.48 **	119	0.16
Total	Event	130	0.57 **	118	0.23 *
Interval	Total	518	0.44 **	500	0.18 **
Interval	Event	517	0.29 **	500	0.00

* $.01 < p \leq .05$

** $p \leq .01$

Sex differences are relatively small for most categories. A larger proportion of boys report exposure to firearms, loud stereo and farm machinery than girls, while a higher percentage of girls reported exposure to amplified musical instruments and, in the younger age group, to loud TV.

The median total noise scores obtained from the interval noise exposure histories (Figure 48) indicate consistent sex differences and age trends. For boys and girls, the median total noise scores from the interval histories tend to increase with age. At most ages, boys have greater median total noise scores than girls, the differences becoming most pronounced after the age of 10 years, when the boys' medians increase rapidly. The difference between boys and girls becomes greatest at 16 years of age, when it is about 18 points.

The age trend in noise exposure as measured by Spearman rank correlation coefficients, is evident in total noise exposure histories (Table 66). The correlations in boys are all highly significant and tend to be considerably higher (.3 to .6) than in girls (0 to .02).

A number of questions on the interval noise questionnaire are "flagged" primarily to indicate changes in the activity patterns of the participant and his family that may be related to noise exposure. The percentage of children with "flagged" responses to questions from the interval noise exposure history are given in Table 67. The precise questions asked are found in Appendix C of Roche et al. (1977). The data in Table 67 generally indicate the changes in jobs, hobbies, recreation, etc., that are possibly noise related.

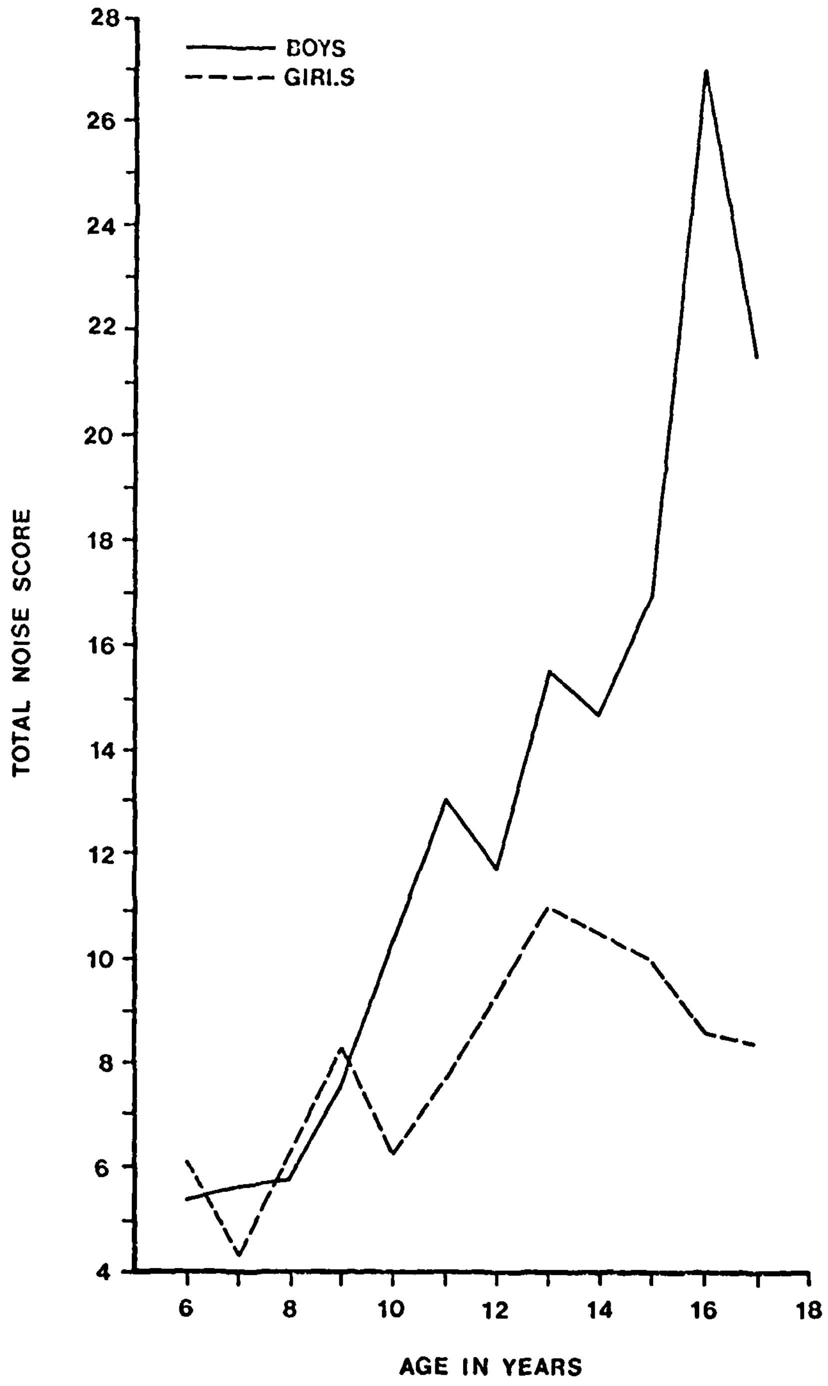

FIGURE 48 -MEDIAN TOTAL NOISE SCORES FROM INTERVAL NOISE EXPOSURE HISTORIES FOR BOYS AND GIRLS

TABLE 67 - PERCENTAGE OF EXAMINATIONS WITH SPECIFIC QUESTIONS "FLAGGED" ON INTERVAL NOISE EXPOSURE HISTORIES

	Question	Percentage of Children
17	family hobbies-noise relevant changes	4.5
19	participant's job-noise relevant change	10.3
20	father's job-noise relevant change	1.6
21	mother's job-noise relevant change	1.4
22	new hobbies-noise relevant activity	8.2
26	hearing protectors - worn for activities other than shooting	4.4

Based on data from about 1016 examinations

CHILDREN WITH UNUSUAL HEARING LOSS OVER A SIX-MONTH INTERVAL DURING THE FIRST TWO YEARS OF THE STUDY

Hearing loss during the period studied is indicated by large positive increments in thresholds. Children were selected who had threshold increments greater than the 90th percentile (Tables 36-58) for at least four frequencies, considering both ears; there were four such children.

No. 594. This 16-year-old girl had six-month increments of 10 and 12 dB at 2000 Hz and 4000 Hz, respectively in the right ear, and increments of 12, 20, and 18 dB at 2000 Hz, 4000 Hz, and 6000 Hz, respectively in the left ear. Her increments at the other frequencies did not differ greatly from those in the rest of the sample. She had a cold, but no ear problems at the time of the second examination, and had rather normal otoscopic findings. Her total noise scores were moderate; 8.9 and 16.9, for her first and second visits

respectively. For the latter visit, most of the noise exposure came from loud television, and being close to gasoline lawnmowers and electric power tools (lawn edgers, drills, etc.) during the six-month interim. During the past 3 years, this participant has shown a slight improvement in hearing ability. Her noise scores have been markedly irregular; the average across periods is close to the average for all girls. Recently her main sources of noise exposure have been radio, motorboats, waterskiing and a gas lawnmower.

No. 697. This 11-year-old girl had a hearing loss at each frequency except 6000 Hz. The six-month increments of 12 and 16 dB at 1000 and 500 Hz, respectively in the right ear, and 12 dB at 500 Hz in the left ear are above the 90th percentiles for those frequencies. In addition, increments of 10 dB at 4000 Hz in the right ear, and 8 dB at 1000 Hz in the left ear equal the 90th percentiles at those frequencies. The otological inspections indicated meatal abnormalities, particularly for the left ear. There was no indication that interim general health was responsible for the hearing loss. The girl's total noise scores (total period and interval) for the first two examinations were 8.7 and 3.3, which approximate the 75th and 25th percentiles respectively for total noise distribution. Her responses to questionaires indicated she had some exposure to gun fire but probably not sufficient to affect her hearing.

This participant has continued to show a marked hearing loss until the most recent visit when there was a marked improvement at all frequencies. Her exposure to noise during the past 3 years has been slightly greater than average. The main sources of noise exposure are minibikes and go-carts (less than 1 hour per week) and riding in school bus (20 minutes each way).

No. 801. This 10-year-old boy had increments of 22, 14, 18, and 16 dB at 1000, 2000, 4000 and 6000 Hz, respectively, in the right ear; and 10 dB at 1000 and 2000 Hz in the left ear between his first and second examinations. The other increments showed little change except an 8 dB decrease at 500 Hz in the right ear. His otological inspection was normal except that a cone of light was not seen at either visit. During the second examination, the boy talked frequently throughout the testing procedure, somehow cut his finger on the arm of the chair, and apparently was very sleepy (9:00 a.m.), yawning between talking and worrying about the small cut. It was concluded that the marked hearing losses indicated by the boy's increments were artifactual due to inattention, distraction, etc., during the second visit. His total noise scores (total period and interval) at the visits were very low, 2.0 and 3.7, respectively. However, there have not been marked changes in auditory thresholds during the last three years. His noise exposure levels continue to be very low.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS, RESULTS FROM OTOLOGICAL INSPECTIONS, AND GENERAL HEALTH AT TIME OF TEST

In Table 3 were presented the rating codes used for describing the otological and general health of the participants at the time of their examinations. In order to test whether these factors are associated with alterations in hearing acuity, t-tests were performed comparing the mean thresholds at each frequency for all examinations indicating normal findings, with those indicating abnormal findings. These comparisons are summarized in Tables 68 through 73. There are few children with abnormal tragi, and there is no indication from the differences in the mean thresholds that there is a significant association between abnormal tragi and thresholds (Table 68); although the thresholds in the abnormal ears tend to be higher than those of the normal ears.

Differences between normal and abnormal ears, with reference to the meatus, ear drum, and visualizing the cone of light are statistically significant ($p < 0.05$), with the exception of 6000 Hz in the right ear (Tables 69 through 71). The reason for this consistent exception is unknown.

Significant differences between normal and abnormal ears regarding ear drum color (Table 72) are less regular than those of the other otological findings. Nevertheless, the mean thresholds in ears with normal drum color are always less than those with abnormal findings and the differences are significant ($p < 0.05$) at 500, 2000 and 6000 Hz in the right ear, and at 500, 1000 and 2000 Hz in the left ear. Similarly, for participants

TABLE 68 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS OF THE TRAGUS[1]

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
RIGHT EAR						
500	1095	-0.60	6	-0.33	-0.27	0.93
1000	1102	-1.30	6	-1.33	0.03	0.99
2000	1104	-2.06	6	-0.33	-1.76	0.58
4000	1103	0.31	6	4.00	-3.69	0.28
6000	1100	0.43	6	4.00	-3.57	0.35
LEFT EAR						
500	1067	-1.85	6	-0.67	-1.18	0.72
1000	1076	-2.25	6	-1.33	-0.92	0.80
2000	1083	-2.79	6	1.00	-3.79	0.29
4000	1078	0.36	6	2.67	-2.31	0.56
6000	1074	0.96	6	2.67	-1.71	0.68

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 69 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS OF THE MEATUS[1]

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
RIGHT EAR						
500	760	-1.01	341	0.30	-1.31	0.01
1000	767	-1.56	341	-0.72	-0.84	0.08
2000	768	-2.40	342	-1.27	-1.13	0.02
4000	767	-0.22	342	1.57	-1.79	0.00
6000	764	0.14	342	1.13	-0.99	0.10
LEFT EAR						
500	776	-2.55	296	0.00	-2.55	0.00
1000	785	-2.89	296	-0.54	-2.35	0.00
2000	788	-3.37	300	-1.18	-2.19	0.00
4000	784	-0.37	299	2.35	-2.72	0.00
6000	782	0.20	297	3.03	-2.83	0.00

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 70 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS OF THE EAR DRUM[1]

RIGHT EAR Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	897	-0.99	200	1.14	-2.13	0.00
1000	904	-1.50	200	-0.37	-1.13	0.05
2000	906	-2.30	200	-0.99	-1.31	0.03
4000	905	0.03	200	1.54	-1.51	0.02
6000	902	0.27	200	1.16	-0.89	0.22
LEFT EAR						
500	866	-2.46	198	0.75	-3.21	0.00
1000	875	-2.67	198	-0.39	-2.28	0.00
2000	880	-3.30	200	-0.57	-2.73	0.00
4000	874	-0.22	201	2.80	-3.02	0.00
6000	873	0.53	198	2.89	-2.36	0.00

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 71 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS OF THE EAR DRUM CONE OF LIGHT[1]

RIGHT EAR Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	675	-1.03	426	0.08	-1.11	0.02
1000	679	-1.68	429	-0.70	-0.98	0.04
2000	680	-2.39	430	-1.53	-0.86	0.06
4000	680	-0.17	429	1.12	-1.29	0.01
6000	677	0.25	429	0.76	-0.51	0.37
LEFT EAR						
500	669	-2.47	402	-0.81	-1.66	0.00
1000	678	-2.65	402	-1.56	-1.09	0.05
2000	682	-3.27	405	-1.97	-1.30	0.02
4000	678	-0.17	404	1.27	-1.44	0.02
6000	676	0.41	402	1.93	-1.52	0.02

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 72 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS OF EAR DRUM COLOR[1]

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
RIGHT EAR						
500	738	-1.09	253	0.32	-1.41	0.01
1000	740	-1.72	255	-0.37	-1.35	0.01
2000	740	-2.31	257	-1.72	-0.60	0.29
4000	739	0.03	257	1.18	-1.15	0.06
6000	739	0.22	256	0.84	-0.62	0.36
LEFT EAR						
500	717	-2.33	253	-0.98	-1.35	0.03
1000	721	-2.57	254	-1.44	-1.13	0.08
2000	728	-2.77	255	-2.53	-0.24	0.70
4000	725	0.40	254	0.96	-0.56	0.43
6000	722	0.61	253	2.04	-1.43	0.05

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 73 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATION OF CHILDREN WITH NORMAL AND ABNORMAL GENERAL HEALTH HISTORIES[1]

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
RIGHT EAR						
500	844	-1.00	210	0.35	-0.65	0.02
1000	848	-1.55	213	-0.76	-0.79	0.17
2000	850	-2.40	213	-1.00	-1.40	0.02
4000	850	0.03	212	0.82	-0.79	0.21
6000	847	0.14	212	1.36	-1.22	0.09
LEFT EAR						
500	776	-2.48	234	-0.62	-1.86	0.00
1000	785	-2.70	234	-1.42	-1.28	0.05
2000	790	-3.32	236	-1.68	-1.64	0.01
4000	785	0.01	236	0.48	-0.47	0.50
6000	783	0.69	234	1.21	-0.52	0.48

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

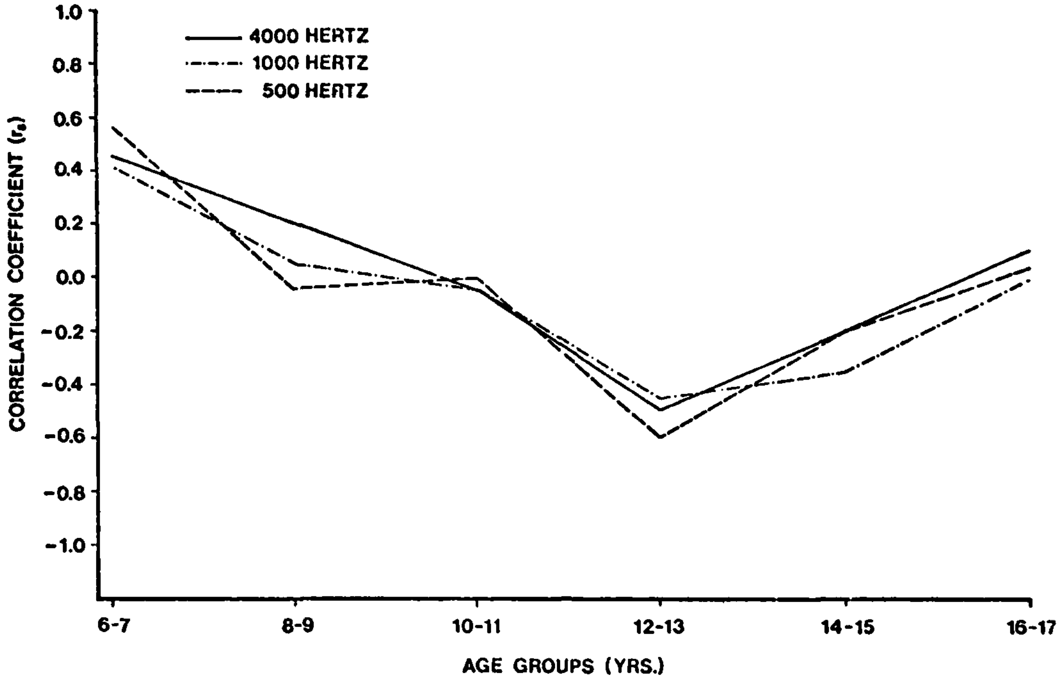

FIGURE 49 -SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN AUDITORY THRESHOLDS AND STATURE IN THE WORSE EAR OF GIRLS

indicating normal general health responses, the mean thresholds are systematically lower than those with abnormal general health (Table 73); these differences reach significance ($p < 0.05$) at 4 of the 10 frequencies.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS AND SIZE AND MATURATION

STATURE

To evaluate associations between auditory thresholds and size, stature was correlated with the auditory thresholds in the better and worse ears, partialling out age (Table 74). The only statistically significant association is with girls' better ear threshold at 2000 Hz (-0.17), while the other correlations in each sex fluctuate about zero. Given the total number of correlations calculated (28), and the lack of any definite pattern, there is little from this analysis to suggest any association between stature and auditory thresholds.

Because it is possible that age is not a linear covariate of stature and auditory thresholds, correlations between stature and auditory thresholds were calculated within two-year age groups. For boys, correlations approximated zero across the

TABLE 74 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN STATURE AND AUDITORY THESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=346)	Girls (n=318)
Better Ear		
500	-0.07	-0.04
1000	0.01	-0.04
2000	0.01	-0.17 **
4000	0.05	-0.05
6000	-0.01	-0.02
M512	-0.01	-0.08
D4	-0.06	0.02
Frequency (Hz)	**Boys (n=335)**	**Girls (n=308)**
Worse Ear		
500	-0.05	-0.03
1000	0.02	-0.01
2000	-0.01	-0.11
4000	-0.07	-0.05
6000	-0.03	-0.01
M512	0.00	-0.06
D4	0.08	0.04

** $p \leq .01$

age groups. For girls, however, an interesting trend was apparent at all frequencies, especially in the worse ear. The correlations for selected frequencies are presented in Figure 49; similar patterns are seen at other frequencies. In the youngest age group (6 to 7 years) stature is significantly and positively correlated ($p < 0.001$) with thresholds, that is, taller girls tend to have worse hearing than relatively shorter girls. The correlations systematically decrease with age until about the end of pubescence (12 to 13 years), when the correlations are significantly negative ($p < 0.001$), that is, taller girls have relatively better hearing than shorter girls in this age group. After this age, the correlations increase again approaching and slightly exceeding zero. While it is not unusual for correlations between variables to decrease markedly during pubescence because of differences in maturational rate, that the pattern of correlations changes qualitatively (i.e., from positive to negative) is unexpected. Further, if this pattern were maturational, one would expect to see a similar pattern in boys about two years after it occurs in girls; this is not the case.

SKELETAL AGE

Relative skeletal age was used as one measure of maturity. This is the difference between skeletal age and chronological age (skeletal age less chronological age) expressed in years. The skeletal age employed is the mean of the bone-specific skeletal ages of the hand-wrist obtained using the Greulich-Pyle atlas (1959). When all ages were included and age was partialled from both variables (Table 75), the correlations were near zero, although there was a slight tendency to negative values in the boys indicating that more mature boys might have lower thresholds. Corresponding correlations within two-year age groups (Tables 76 through 81) showed a generally similar pattern, except that the correlations were positive at most frequencies for girls aged 6-7, and 8-9 years. There were, however, significant negative correlations for girls aged 12-13 years. The correlations for girls showed a marked tendency to be positive to 11 years and negative at older ages.

Correlations were calculated also between auditory thresholds and skeletal age with the effects of stature removed (Tables 82-89). There are few significant correlations except for positive values in boys from 10 to 13 years, and in girls from 8 to 9 years. In general, the correlations tend to be larger in boys than girls and tend to be positive indicating that more mature children tend to have higher thresholds. This pattern is more marked in the data from the left ear than from the right ear, but there is little difference in the strength of the associations in their pattern when findings from the better and worse ears are compared.

MENARCHE

Age at menarche was obtained by inquiry each 6 months from the Fels participants. Correlations between auditory thresholds

TABLE 75 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys n	Boys r	Girls n	Girls r
Better Ear				
500	280	-0.05	249	-0.02
1000	281	-0.05	253	0.03
2000	281	0.07	254	0.08
4000	281	0.05	253	0.07
6000	280	-0.12 *	252	0.06
M512	280	-0.01	249	0.01
D4	281	-0.11	252	-0.08
Worse Ear				
500	268	-0.06	239	-0.04
1000	273	-0.05	243	0.06
2000	276	0.07	245	0.03
4000	276	-0.04	243	0.05
6000	272	-0.11	242	-0.03
M512	268	0.00	239	0.01
D4	273	-0.06	241	-0.02

* $.01 < p \leq .05$

TABLE 76 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 6-7 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	37	-0.10	25	0.30
1000	37	-0.07	27	0.26
2000	37	-0.18	28	0.03
4000	37	0.10	27	0.64 **
6000	37	-0.32	26	0.41 *
M512	37	-0.14	25	0.09
D4	37	-0.16	26	-0.48 *
Worse Ear				
500	29	-0.16	20	0.38
1000	32	-0.04	22	0.49 *
2000	35	-0.09	23	0.55 **
4000	35	-0.06	22	0.50 *
6000	31	-0.25	21	0.40
M512	29	-0.10	20	0.52 *
D4	32	-0.01	21	-0.31

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 77 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 8-9 YEARS OF AGE

Frequency (Hz)	Boys n	Boys r	Girls n	Girls r
Better Ear				
500	36	-0.10	55	0.13
1000	36	-0.20	56	0.17
2000	36	0.11	56	0.36 **
4000	36	0.02	56	0.24
6000	36	0.02	56	0.32 *
M512	36	-0.07	55	0.25
D4	36	-0.25	56	-0.05
Worse Ear				
500	35	-0.17	51	0.33 *
1000	35	-0.18	53	0.40 **
2000	35	0.04	54	0.43 **
4000	35	-0.21	53	0.20
6000	35	0.05	53	0.28 *
M512	35	-0.11	51	0.45 **
D4	35	-0.15	52	0.29 *

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 78 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 10-11 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	55	-0.08	50	0.06
1000	55	0.05	50	0.04
2000	55	0.29 *	50	0.24
4000	55	0.08	50	-0.06
6000	55	-0.13	50	0.10
M512	55	0.15	50	0.13
D4	55	-0.10	50	-0.02
Worse Ear				
500	52	-0.15	50	0.14
1000	54	-0.05	50	0.06
2000	54	0.17	50	0.15
4000	54	0.09	50	0.04
6000	54	-0.14	50	0.13
M512	52	-0.10	50	0.15
D4	54	-0.09	50	-0.06

* $.01 < p \leq .05$

TABLE 79 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 12-13 YEARS OF AGE

Frequency (Hz)	Boys n	Boys r	Girls n	Girls r
Better Ear				
500	53	0.37 **	64	-0.45 **
1000	53	0.26	65	-0.33 **
2000	53	0.44 **	65	-0.33 **
4000	53	0.28 *	65	-0.30 *
6000	53	0.15	65	-0.37 **
M512	53	0.43 **	64	-0.43 **
D4	53	-0.13	65	0.03
Worse Ear				
500	53	0.42 **	64	-0.56 **
1000	53	0.33 *	64	-0.35 **
2000	53	0.45 **	64	-0.51 **
4000	53	0.16	64	-0.33 **
6000	53	0.18	64	-0.53 **
M512	53	0.54 **	64	-0.56 **
D4	53	0.06	64	-0.01

* $.01 < p \leq .05$

** $p \leq .01$

 No page 159

TABLE 80 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 14-15 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	47	-0.17	30	0.17
1000	47	-0.09	30	0.16
2000	47	-0.02	30	0.41 *
4000	47	-0.03	30	0.30
6000	47	-0.25	30	0.21
M512	47	-0.13	30	0.21
D4	47	0.06	30	-0.18
Worse Ear				
500	47	-0.06	30	0.09
1000	47	-0.05	30	0.18
2000	47	0.04	30	0.42 *
4000	47	-0.13	30	0.16
6000	47	-0.31 *	30	0.17
M512	47	-0.02	30	0.23
D4	47	0.09	30	-0.03

* $.01 < p \leq .05$

TABLE 81 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH IN CHILDREN 16-17 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	38	-0.10	23	-0.20
1000	38	-0.14	23	0.01
2000	38	-0.23	23	-0.15
4000	38	0.02	23	-0.13
6000	38	-0.25	23	-0.41
M512	38	-0.16	23	-0.17
D4	38	-0.05	23	0.12
Worse Ear				
500	38	-0.17	23	-0.20
1000	38	-0.14	23	-0.24
2000	38	-0.09	23	-0.58 **
4000	38	-0.14	23	-0.05
6000	38	-0.10	23	-0.50 *
M512	38	-0.13	23	-0.39
D4	38	0.12	23	-0.06

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 82 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND RIGHT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	6-7 yrs. r	8-9 yrs. n	8-9 yrs. r	10-11 yrs. n	10-11 yrs. r
Right Ear-Boys						
500	35	-0.19	36	-0.19	54	-0.03
1000	36	-0.12	36	-0.22	55	-0.01
2000	37	-0.13	36	0.07	55	0.34 **
4000	37	-0.15	36	0.00	55	0.35 **
6000	36	-0.26	36	0.11	55	0.15
M512	35	-0.22	36	-0.12	54	0.11
D4	36	-0.08	36	-0.28	55	-0.38 **
Right Ear-Girls						
500	25	0.09	54	0.39**	43	-0.09
1000	27	0.37	55	0.47**	43	0.00
2000	28	0.23	55	0.33**	43	0.13
4000	27	0.31	55	0.21	43	-0.06
6000	26	0.36	55	0.13	43	0.01
M512	25	0.20	54	0.49**	43	0.04
D4	26	-0.09	55	0.19	43	-0.03

** P < .01

TABLE 83 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND RIGHT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs. n	12-13 yrs. r	14-15 yrs. n	14-15 yrs. r	16-17 yrs. n	16-17 yrs. r
Right Ear-Boys						
500	49	0.50**	45	-0.14	35	-0.21
1000	49	0.19	45	-0.20	35	-0.20
2000	49	0.52**	45	-0.08	35	-0.08
4000	49	0.37**	45	-0.28	35	-0.11
6000	49	0.38**	45	-0.23	35	-0.06
M512	49	0.56**	45	-0.11	35	-0.15
D4	49	-0.23	45	0.18	35	0.00
Right Ear-Girls						
500	63	-0.17	27	0.12	22	-0.04
1000	64	0.00	27	0.07	22	0.16
2000	64	-0.06	27	0.22	22	-0.18
4000	64	0.06	27	0.27	22	0.14
6000	64	-0.09	27	-0.09	22	-0.17
M512	63	-0.11	27	0.17	22	0.04
D4	64	-0.04	27	-0.07	22	-0.11

** $p < .01$

TABLE 84 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN RELATIVE SKELETAL AGE AND LEFT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequence	6-7 yrs.		8-9 yrs.		10-11 yrs.	
(Hz)	n	r	n	r	n	r
Left Ear-Boys						
500	31	0.09	35	-0.03	53	-0.07
1000	33	0.00	35	-0.06	54	-0.02
2000	35	0.05	35	0.08	54	0.36 **
4000	35	0.18	35	0.15	54	-0.06
6000	32	-0.16	35	0.01	54	-0.07
M512	31	0.04	35	0.03	53	0.19
D4	33	-0.14	35	-0.24	54	-0.05
Left Ear-Girls						
500	20	0.14	50	0.18	43	0.22
1000	22	0.21	52	0.12	43	0.00
2000	23	0.01	53	0.36 **	43	0.25
4000	22	0.63	52	0.21	43	0.00
6000	21	0.39	52	0.21	43	0.06
M512	20	0.18	50	0.28 *	43	0.21
D4	21	-0.59 **	51	-0.01	43	-0.04

* P <.05

** P <.01

TABLE 85 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND LEFT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs. n	12-13 yrs. r	14-15 yrs. n	14-15 yrs. r	16-17 yrs. n	16-17 yrs. r
Left Ear-Boys						
500	49	0.31 *	45	-0.16	35	-0.11
1000	49	0.18	45	-0.07	35	-0.11
2000	49	0.30 *	45	0.11	35	-0.20
4000	49	0.25	45	-0.02	35	-0.06
6000	49	0.31 *	45	-0.18	35	-0.10
M512	49	0.32 *	45	-0.06	35	-0.13
D4	49	-0.16	45	0.03	35	0.06
Left Ear-Girls						
500	63	-0.27 *	27	0.04	22	-0.07
1000	63	-0.12	27	-0.01	22	-0.15
2000	63	-0.13	27	0.25	22	-0.04
4000	63	-0.17	17	0.04	22	0.05
6000	63	-0.17	27	0.05	22	-0.36
M512	63	-0.19	27	0.07	22	-0.08
D4	63	0.13	27	-0.05	22	-0.07

* $.01 < p \leq .05$

TABLE 86 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN RELATIVE SKELETAL AGE AND BETTER EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	6-7 yrs. r	8-9 yrs. n	8-9 yrs. r	10-11 yrs. n	10-11 yrs. r
Better Ear-Boys						
500	37	-0.06	36	-0.04	55	-0.03
1000	37	0.00	36	-0.11	55	0.02
2000	37	-0.11	36	0.12	55	0.38 **
4000	37	0.07	36	0.19	55	0.11
6000	37	-0.26	36	0.03	55	0.07
M512	37	-0.04	36	0.00	55	0.21
D4	37	-0.03	36	-0.31	55	-0.17
Better Ear-Girls						
500	25	0.09	54	0.19	43	0.04
1000	27	0.21	55	0.22	43	0.03
2000	28	-0.09	55	0.43 **	43	0.31 *
4000	27	0.61 **	55	0.17	43	-0.04
6000	26	0.38 *	55	0.22	43	0.01
M512	25	0.01	54	0.29 *	43	0.16
D4	26	-0.55 **	55	0.06	43	-0.02

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 87 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND BETTER EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs. n	r	14-15 yrs. n	r	16-17 yrs. n	r
Better Ear-Boys						
500	49	0.47 **	45	-0.18	35	-0.14
1000	49	0.19	45	-0.13	35	-0.20
2000	49	0.37 **	45	0.02	35	-0.25
4000	49	0.35 **	45	-0.14	35	-0.01
6000	49	0.39 **	45	-0.17	35	-0.17
M512	49	0.39 **	45	-0.13	35	-0.19
D4	49	-0.21	45	0.11	35	-0.07
Better Ear-Girls						
500	63	-0.18	27	0.08	22	0.02
1000	64	-0.03	27	0.09	22	-0.23
2000	64	-0.11	27	0.22	22	-0.09
4000	64	-0.10	27	0.20	22	0.10
6000	64	-0.09	27	-0.04	22	-0.14
M512	63	-0.13	27	0.04	22	-0.11
D4	64	0.06	27	-0.15	22	-0.13

** $p \leq .01$

TABLE 88 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND WORSE EAR AUDITORY THRESHOLD (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	6-7 yrs. r	8-9 yrs. n	8-9 yrs. r	10-11 yrs. n	10-11 yrs. r
Worse Ear-Boys						
500	29	-0.03	35	-0.16	52	-0.13
1000	32	-0.11	35	-0.13	54	0.00
2000	35	0.02	35	0.03	54	0.37 **
4000	35	0.02	35	-0.09	54	0.27 *
6000	31	-0.21	35	0.03	54	0.03
M512	29	-0.13	35	-0.03	52	0.11
D4	32	-0.24	35	-0.16	54	-0.25
Worse Ear-Girls						
500	20	0.24	50	0.37 **	43	0.07
1000	22	0.47	52	0.36 **	43	0.00
2000	23	0.42 *	53	0.39 **	43	0.19
4000	22	0.52 **	52	0.24	43	-0.01
6000	21	0.40	52	0.15	43	0.16
M512	20	0.43	50	0.47 **	43	0.11
D4	21	-0.34	41	0.18	43	-0.07

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 89 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RELATIVE SKELETAL AGE AND WORSE EAR AUDITORY THRESHOLD (dB) WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs. n	r	14-15 yrs. n	r	16-17 yrs. n	r
Worse Ear-Boys						
500	49	0.44 **	45	-0.11	35	-0.21
1000	49	0.24	45	-0.13	35	-0.14
2000	49	0.45 **	45	0.09	35	-0.11
4000	49	0.30 *	45	-0.14	35	-0.13
6000	49	0.35 *	45	-0.25	35	0.00
M512	49	0.51 **	45	-0.06	35	-0.14
D4	49	-0.16	45	0.05	35	0.10
Worse Ear-Girls						
500	63	-0.29 *	27	0.08	22	-0.09
1000	63	-0.09	27	0.11	22	0.13
2000	63	-0.16	27	0.29	22	-0.21
4000	63	-0.03	27	0.09	22	0.18
6000	63	-0.16	27	0.02	22	-0.37
M512	63	-0.16	27	0.15	22	-0.01
D4	63	-0.01	27	0.01	22	0.10

* $.01 < p \leq .05$

** $p \leq .01$

at the last examination before menarche and age at menarche were calculated after removing the effects of age from each variable (Table 90). The coefficients are usually positive indicating that girls who are late to reach menarche tend to have higher thresholds but few of the coefficients are significant.

Corresponding correlations using thresholds obtained at the first examination after menarche were not significant and the majority were positive (Table 91).

Correlations were calculated between auditory thresholds and age at menarche with stature partialled from both (Tables 92 and 93); this procedure has the effect of separating growth from maturity. There are few significant correlations (16/112), but these are positive and indicate more rapidly maturing girls at 12-13 years and 16-17 years tend to have higher thresholds, irrespective of stature. The small samples in the 10-11 year groups occur because few girls reached menarche so early.

Correlations were calculated within age groups between auditory thresholds and stature, partialling out skeletal age and age at menarche (Tables 94 and 95); this has the effect of separating maturational effects associated wi'h the skeleton and with the reproductive system from stature. For 12- and 13-year-old girls these correlations are significantly negative, indicating these girls who are relatively tall have lower thresholds, i.e., better hearing, than shorter girls, irrespective of maturity status.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS AND NOISE SCORES

To investigate associations between noise and hearing acuity, auditory thresholds were correlated with the noise score from the interval noise history covering the previous 6-month period. For these analyses, the "worse ear" threshold was considered the more important because noise-induced hearing loss is more likely to be apparent in the worse ear and, accordingly, associations with noise are more likely to be demonstrated in the worse ear. Correlations between interval noise scores and auditory thresholds for all examinations are presented for better and worse ear in Table 96 for boys; the correlations are all low and negative. Because of the large sample involved, 9 of the 14 correlations for boys are significant ($p < 0.05$). These associations indicate the higher noise scores are associated with better hearing (lower thresholds). In girls, all of the correlations but one (D4, better ear) approximate zero and are not significant.

TABLE 90 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN THE LAST AUDITORY THRESHOLD BEFORE MENARCHE AND AGE OF MENARCHE WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Right Ear r	Left Ear r	Better Ear r	Worse Ear r
Girls (n=18)				
500	0.07	0.05	0.03	0.09
1000	0.22	0.12	0.01	0.29
2000	-0.03	0.07	0.20	-0.07
4000	-0.11	-0.04	-0.23	-0.01
6000	0.16	0.59 **	0.16	0.52 *
M512	0.09	0.18	0.18	0.18
D4	0.27	0.19	0.11	0.30

* $.01 < p \leq .05$

** $p < .01$

TABLE 91 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN THE FIRST AUDITORY THRESHOLD AFTER MENARCHE AND AGE AT MENARCHE WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Right Ear r	Left Ear r	Better Ear r	Worse Ear r
Girls (n=62)				
500	0.06	0.20	0.13	0.17
1000	0.09	0.16	0.18	0.08
2000	-0.11	-0.03	-0.05	-0.10
4000	0.04	0.18	0.15	0.09
6000	0.09	0.14	0.17	0.09
M512	0.01	0.10	0.10	0.03
D4	0.05	-0.09	-0.01	-0.05

TABLE 92 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) IN GIRLS BETWEEN RIGHT AND LEFT EAR AUDITORY THRESHOLDS AND AGE AT MENARCHE WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r
Right Ear								
500	7	0.14	47	0.14	32	0.11	32	0.14
1000	7	-0.43	48	-0.03	32	0.12	32	0.27
2000	7	0.21	48	0.35*	32	-0.25	32	0.18
4000	7	0.04	48	-0.05	32	-0.08	32	0.09
6000	7	0.68	48	0.29*	32	0.30	32	0.11
M512	7	-0.14	47	0.22	32	0.00	32	0.25
D4	7	-0.04	48	0.04	32	0.16	32	0.06
Left Ear								
500	7	0.21	47	0.30*	32	0.22	32	0.55**
1000	7	0.32	47	0.24	32	0.27	32	0.43*
2000	7	0.07	47	0.13	32	-0.01	32	0.28
4000	7	0.50	47	0.12	32	0.08	32	0.53**
6000	7	-0.14	47	0.36*	32	0.17	32	0.35
M512	7	0.21	47	0.26	32	0.16	32	0.49**
D4	7	-0.21	47	0.02	32	0.12	32	-0.34

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 93 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) IN GIRLS BETWEEN BETTER AND WORSE EAR AUDITORY THRESHOLDS AND AGE AT MENARCHE WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Better Ear								
500	7	0.07	47	0.18	32	0.18	32	0.24
1000	7	0.21	48	0.08	32	0.10	32	0.33
2000	7	-0.21	48	0.22	32	-0.08	32	0.26
4000	7	0.18	48	0.13	32	-0.03	32	0.28
6000	7	0.54	48	0.45**	32	0.25	32	0.12
M512	7	0.07	47	0.22	32	0.11	32	0.29
D4	7	0.07	48	-0.08	32	0.12	32	-0.17
Worse Ear								
500	7	0.43	47	0.32*	32	0.12	32	0.43*
1000	7	-0.43	47	0.17	32	0.19	32	0.38*
2000	7	0.29	47	0.32*	32	-0.21	32	0.27
4000	7	0.43	47	-0.02	32	0.04	32	0.38*
6000	7	0.00	47	0.31*	32	0.24	32	0.25
M512	7	-0.14	47	0.31*	32	0.05	32	0.47**
D4	7	-0.32	47	0.16	32	0.13	32	-0.24

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 94 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) IN GIRLS BETWEEN RIGHT AND LEFT EAR AUDITORY THRESHOLDS AND STATURE WITH THE EFFECTS OF AGE AT MENARCHE AND RELATIVE SKELETAL AGE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Right Ear								
500	4	0.40	40	-0.47**	23	-0.28	19	-0.12
1000	4	0.40	41	-0.57**	23	-0.30	19	-0.28
2000	4	0.80	41	-0.34*	23	-0.25	19	-0.23
4000	4	0.40	41	-0.23	23	-0.09	19	-0.12
6000	4	-0.40	41	-0.19	23	-0.23	19	-0.12
M512	4	0.40	40	-0.55**	23	-0.39	19	-0.25
D4	4	-0.40	41	-0.25	23	0.03	19	-0.09
Left Ear								
500	4	-0.20	40	-0.33*	23	-0.23	19	-0.27
1000	4	0.80	40	-0.47**	23	-0.51*	19	-0.18
2000	4	0.80	40	-0.34*	23	-0.35	19	-0.49*
4000	4	-0.20	40	-0.05	23	-0.32	19	-0.34
6000	4	-0.40	40	-0.27	23	-0.12	19	-0.05
M512	4	0.40	40	-0.43**	23	-0.44*	19	-0.36
D4	4	0.20	40	-0.31	23	-0.16	19	0.35

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 95 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) IN GIRLS BETWEEN BETTER AND WORSE EAR AUDITORY THRESHOLDS AND STATURE WITH THE EFFECTS OF AGE AT MENARCHE AND RELATIVE SKELETAL AGE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
<u>Better Ear</u>								
500	4	0.40	40	-0.35*	23	-0.22	19	-0.19
1000	4	0.40	41	-0.58**	23	-0.56**	19	-0.10
2000	4	0.80	41	-0.38*	23	-0.32	19	-0.39
4000	4	0.40	41	-0.09	23	-0.23	19	-0.26
6000	4	-0.40	41	-0.09	23	-0.16	19	0.14
M512	4	0.40	40	-0.49**	23	-0.41	19	-0.25
D4	4	-0.40	41	-0.34*	23	-0.27	19	0.34
<u>Worse Ear</u>								
500	4	-0.20	40	-0.45**	23	-0.28	19	-0.22
1000	4	0.80	40	-0.52**	23	-0.34	19	-0.35
2000	4	0.80	40	-0.31*	23	-0.35	19	-0.35
4000	4	-0.20	40	-0.23	23	-0.23	19	-0.27
6000	4	-0.40	40	-0.32*	23	-0.16	19	-0.07
M512	4	0.40	40	-0.52**	23	-0.40	19	-0.34
D4	4	0.20	40	-0.25	23	-0.01	19	0.13

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 96 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN INTERVAL NOISE SCORES AND AUDITORY THRESHOLDS

Frequency (Hz)	Boys (n=510)	Girls (n=488)
Worse Ear		
500	-0.20 **	-0.02
1000	-0.15 **	0.02
2000	-0.06	0.00
4000	-0.08	0.05
6000	-0.11 *	0.05
M512	-0.18 **	0.01
D4	-0.07	-0.05

Frequency (Hz)	Boys (n=519)	Girls (n=495)
Better Ear		
500	-0.19 **	0.01
1000	-0.15 **	-0.08
2000	-0.06	-0.02
4000	-0.06	0.05
6000	-0.14 **	0.06
M512	-0.16 **	-0.04
D4	-0.09 *	-0.13 **

* $.01 < p \leq .05$

** $p \leq .01$

While these findings in boys are contrary to a hypothesis of noise-induced hearing loss, it should be remembered that age is associated significantly with noise scores and auditory thresholds, but in opposite directions. Consequently, age was linearly partialled independently from auditory thresholds and noise scores and the age-adjusted variables were correlated (Table 97). Most of the significant correlations in boys between noise scores and thresholds (Table 96) were due to an artifactual age effect. Nevertheless, in boys, the correlations are still negative, although now 2 of 14 are significantly different from zero. For girls, these correlations suggest there may be some noise effect at 500, 4000, and 6000 Hz, although the qualitative sex difference in this association is difficult to explain.

Because of the measurement error inherent in both the derivation of the noise scores and in the auditory thresholds, means for each individual were calculated for these variables across visits. When these age-adjusted mean variables were correlated, no statistically significant association was found (Table 98). The pattern of signs of the correlations (boys negative, girls positive) is generally similar to that for the correlation of the age-adjusted values for each examination (Table 97).

Correlation coefficients between interval noise scores and auditory thresholds for right, left, better, and worse ears, within two-year age groups are presented in Tables 99 through 102. Correlations in boys tend to be low and erratic. The few significant correlations for boys (3/168) are no more than would be expected by chance. In girls, the sign of the correlations are generally similar within an age group, but the sign changes from group to group. While the sign and significance of correlations in girls 8-9 years and 14-15 years suggest higher noise exposure is associated with higher thresholds, the opposite trend occurs at 6-7 years and 10-11 years of age. It is difficult to conceive of a biological phenomena that would change qualitatively in this manner.

To utilize the serial nature of these data, straight lines were fitted by regression to each individual's data for noise score versus age, and for auditory thresholds versus age. The individual slopes (b values) represent the rates of change in the variables. The effects of age were partialled out of these individual slopes by linear regression analyses (using mean age of each individuals's data points), and the age-adjusted results for rates of change in noise scores and thresholds were correlated; these are presented for the worse ear in Table 103. These correlations tend to be negative and are significantly different from zero at 500 Hz in boys and at 6000 Hz in girls. This analysis indicates that, at these frequencies, those children showing more rapid increases in noise exposure tend to gain hearing acuity.

TABLE 97 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN INTERVAL NOISE SCORES AND AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=515)	Girls (n=486)
Worse Ear		
500	-0.10 *	0.05
1000	-0.07	0.05
2000	-0.01	0.04
4000	-0.05	0.08
6000	-0.08	0.07
M512	-0.10 *	0.07
D4	-0.01	-0.04

Frequency (Hz)	Boys (n=519)	Girls (n=496)
Better Ear		
500	-0.06	0.09 *
1000	-0.05	-0.03
2000	-0.01	0.05
4000	-0.03	0.09 *
6000	-0.06	0.10 *
M512	-0.04	0.05
D4	-0.02	-0.13 **

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 98 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN MEAN INTERVAL NOISE SCORES AND THE MEAN OF AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=107)	Girls (n=101)
Worse Ear		
500	-0.10	0.03
1000	-0.16	0.05
2000	-0.07	0.05
4000	-0.02	0.10
6000	-0.10	0.17
M512	-0.15	0.07
D4	-0.04	-0.05

Frequency (Hz)	Boys (n=107)	Girls (n=101)
Better Ear		
500	-0.12	0.04
1000	-0.13	-0.12
2000	-0.05	0.03
4000	-0.02	0.10
6000	-0.15	0.13
M512	-0.11	0.00
D4	-0.01	-0.15

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 99 - SPEARMAN RANK CORRELATION COEFFICIENTS (rs) BETWEEN INTERVAL NOISE SCORES AND RIGHT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs		8-9 yrs		10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r	n	r	n	r
Right Ear - Boys												
500	59	-0.02	77	0.04	71	0.05	68	-0.06	113	-0.18	106	-0.19
1000	59	-0.10	77	0.09	72	0.08	68	0.06	113	0.01	106	-0.19
2000	60	0.10	77	0.11	72	0.15	68	0.06	113	0.10	106	-0.27*
4000	60	0.22	77	-0.07	72	0.04	68	-0.05	113	-0.10	106	-0.19
6000	60	0.04	77	0.02	72	-0.05	68	-0.05	113	-0.10	106	-0.12
M512	59	0.05	77	0.12	71	0.04	68	-0.01	113	-0.06	106	-0.24*
D4	59	-0.28*	77	0.09	72	-0.02	68	0.03	113	0.09	106	0.14
Right Ear - Girls												
500	50	-0.17	60	0.22	56	-0.27*	80	-0.05	136	0.16	94	0.07
1000	51	-0.45**	61	0.08	56	-0.11	80	0.05	136	0.24**	94	-0.05
2000	52	-0.19	61	0.30*	56	-0.24	80	-0.03	136	0.18*	94	0.09
4000	51	-0.07	61	0.20	56	-0.18	80	0.11	136	0.11	94	0.20
6000	50	0.04	61	0.33**	56	-0.08	80	0.18	136	0.11	94	0.02
M512	50	-0.28*	60	0.21	56	-0.28*	80	0.01	136	0.25**	94	0.05
D4	50	-0.28	61	-0.14	56	0.06	80	-0.12	136	0.05	94	-0.23

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 100 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN INTERVAL NOISE SCORES AND LEFT EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs		8-9 yrs		10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r	n	r	n	r
Left Ear - Boys												
500	56	-0.04	75	-0.09	69	0.16	66	-0.08	113	-0.13	106	-0.06
1000	57	-0.09	75	0.08	71	0.00	66	0.09	113	-0.02	106	-0.15
2000	59	0.00	76	0.22	71	0.08	67	0.06	113	0.14	106	-0.18
4000	57	-0.09	76	0.08	71	0.12	67	-0.01	113	0.06	106	-0.06
6000	56	-0.18	75	-0.02	71	0.13	67	-0.17	113	-0.03	106	-0.09
M512	56	-0.07	75	0.10	69	0.06	66	0.03	113	-0.04	106	-0.14
D4	57	-0.04	75	0.04	71	-0.05	66	0.07	113	-0.08	106	-0.02
Left Ear - Girls												
500	43	-0.40**	57	0.31*	56	-0.20	80	0.12	136	0.08	94	0.19
1000	45	-0.19	58	0.09	56	-0.03	80	0.12	136	0.04	94	-0.03
2000	45	-0.23	59	0.26*	56	-0.17	80	0.11	136	0.13	94	0.17
4000	44	0.10	58	0.26	55	-0.27*	80	0.17	136	0.10	94	0.00
6000	44	-0.01	58	0.41**	56	-0.12	80	0.23*	136	-0.01	94	-0.04
M512	43	-0.29	57	0.19	56	-0.17	80	0.13	136	0.09	94	0.14
D4	44	-0.22	57	-0.13	55	0.25	80	-0.13	136	-0.10	94	-0.05

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 101- SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN INTERVAL NOISE SCORES AND BETTER EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs		8-9 yrs		10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r	n	r	n	r
Better Ear - Boys												
500	60	-0.03	77	-0.05	72	0.14	68	-0.05	113	-0.17	106	-0.08
1000	60	-0.01	77	0.05	72	0.04	68	0.00	113	0.01	106	-0.18
2000	60	0.12	77	0.13	72	0.08	68	0.03	113	0.14	106	-0.20
4000	60	0.19	77	0.04	72	0.09	68	-0.04	113	0.02	106	-0.14
6000	60	-0.07	77	-0.09	72	0.05	68	-0.11	113	-0.08	106	-0.12
M512	60	0.01	77	0.07	72	0.09	68	-0.01	113	-0.02	106	-0.18
D4	60	-0.20	77	0.08	72	-0.03	68	-0.05	113	-0.02	106	0.03
Better Ear - Girls												
500	50	-0.23	60	0.31*	56	-0.26*	80	0.06	136	0.13	94	0.16
1000	51	-0.35*	61	0.05	56	-0.05	80	0.06	136	0.04	94	-0.06
2000	52	-0.23	61	0.26*	56	-0.21	80	0.06	136	0.11	94	0.19
4000	51	0.08	61	0.21	56	-0.25	80	0.16	136	0.08	94	0.14
6000	50	-0.01	61	0.38**	56	-0.04	80	0.22*	136	0.04	94	0.05
M512	50	-0.36**	60	0.24	56	-0.20	80	0.09	136	0.13	94	0.10
D4	50	-0.29*	61	-0.08	56	0.23	80	-0.10	136	-0.03	94	-0.20

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 102 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN INTERVAL NOISE SCORES AND WORSE EAR AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Worse Ear - Boys												
500	55	0.00	75	-0.03	68	0.07	66	-0.09	113	-0.18	106	-0.18
1000	56	-0.08	75	0.11	71	0.05	66	0.15	113	-0.04	106	-0.16
2000	59	0.03	76	0.22	71	0.15	67	0.10	113	0.11	106	-0.28
4000	57	-0.01	76	-0.06	71	0.10	67	-0.07	113	-0.05	106	-0.11
6000	56	-0.09	75	0.05	71	0.07	67	-0.12	113	-0.07	106	-0 12
M512	55	-0.02	75	0.13	68	0.04	66	-0.03	113	-0.06	106	-0.25
D4	56	-0.08	75	0.11	71	-0.02	66	0.13	113	0.03	106	0.03
Worse Ear - Girls												
500	43	-0.36*	57	0.21	56	-0.23	80	0.04	136	0.12	94	0.11
1000	45	-0.33*	58	0.08	56	-0.10	80	0.13	136	0.23**	94	-0.03
2000	45	-0.20	59	0.31*	56	-0.28*	80	0.01	136	0.18*	94	0.11
4000	44	-0.09	58	0.30*	55	-0.24	80	0.13	136	0.14	94	0.05
6000	44	0.06	58	0.38**	56	-0.17	80	0.17	136	0.06	94	-0.05
M512	43	-0.31*	57	0.22	56	-0.23	80	0.06	136	0.20*	94	0.10
D4	44	-0.16	57	-0.20	55	0.10	80	-0.11	136	-0.03	94	-0.05

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 103 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN THE SLOPE OF INTERVAL NOISE SCORES AND THE SLOPE OF AUDITORY THRESHOLDS FOR THE WORSE EAR WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=107)	Girls (n=101)
500	-0.20 *	0.05
1000	-0.18	0.03
2000	-0.11	-0.04
4000	-0.12	-0.10
6000	-0.14	-0.24 *
M512	-0.19	-0.05
D4	-0.07	0.18

* $.01 < p \leq .05$

A slightly different analysis than the previous one is to correlate auditory thresholds adjusted for the individual's age change, with noise scores, adjusted for the individual's age change. This analysis is sensitive to noise-associated deviations in auditory thresholds from the individual's own age trend in thresholds. The results are presented in Table 104. The correlations are effectively zero; the one significant correlation is slightly more than what would be expected by chance alone.

To evaluate whether 6-monthly changes in auditory thresholds (increments) were associated with interval noise scores during the same period, correlations were calculated between these two variables, partialling the effects of age. These correlations are presented by age groups in Tables 105-108. These correlations are generally low and not significant, except in girls at 10-11 years. In this group of girls, the correlations are systematically negative and significant, with the highest correlation at 4000 Hz. This analysis indicates that higher noise scores are associated with lower threshold increments, that is, increases in hearing acuity.

TABLE 104 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN WORSE EAR AUDITORY THRESHOLDS AND INTERVAL NOISE SCORES WITH THE EFFECT OF AGE REMOVED SEPARATELY FOR EACH INDIVIDUAL

Frequency (Hz)	Boys		Girls	
	n	r	n	r
500	510	-0.08	488	-0.05
1000	511	0.01	487	-0.04
2000	519	-0.03	496	-0.05
4000	515	0.11 *	489	-0.07
6000	513	-0.03	486	0.04
M512	506	-0.03	485	0.00
D4	506	-0.01	485	-0.07

* $.01 < p \leq .05$

Because the total noise score is a gross estimate of total noise expsosure, it was considered important to determine if specific noise events or groups of noise events were associated with auditory thresholds or changes in thresholds. Table 109 presents the mean thresholds at 4000 Hz in the worse ear for individuals who have been exposed to a specific noise event during the previous six-month interval, and the mean thresholds for individuals not exposed to the same events; significance of differences between the means are tested by t-tests. The differences between means (exposed less unexposed) are calculated so that a positive difference indicates a noise-associated hearing loss. Statistically significant differences between mean thresholds at 4000 Hz for power tools, farm machines, loud T.V. and loud

TABLE 105 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN RIGHT EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Right Ear												
Boys												
500	31	-0.30	49	-0.07	50	-0.29*	49	0.10	89	-0.15	80	0.03
1000	31	-0.23	49	0.04	51	-0.08	49	0.16	89	0.00	80	0.02
2000	33	-0.28	49	-0.10	51	0.18	49	-0.07	89	0.03	80	-0.10
4000	33	-0.10	49	-0.01	51	-0.05	49	0.27	89	0.08	80	-0.05
6000	33	-0.15	49	0.03	51	0.04	49	0.12	89	0.04	80	0.00
M512	31	-0.33	49	-0.11	50	-0.12	49	0.09	89	-0.07	80	0.00
D4	31	-0.19	49	-0.02	51	-0.05	49	-0.18	89	-0.10	80	0.06
Girls												
500	28	0.15	45	0.22	44	-0.29*	58	0.08	102	0.02	67	-0.01
1000	30	0.01	47	0.17	44	-0.35*	59	0.04	102	0.08	67	-0.12
2000	31	0.15	47	0.12	44	-0.36*	59	-0.05	102	-0.01	67	-0.09
4000	29	-0.05	47	0.21	44	-0.37**	59	0.00	102	0.08	67	0.02
6000	28	0.06	47	-0.01	44	-0.34*	59	0.00	102	-0.09	67	0.09
M512	28	0.23	45	0.19	44	-0.46**	58	0.05	102	0.04	67	-0.10
D4	28	-0.06	47	-0.12	44	0.02	59	0.01	102	-0.08	67	-0.10

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 106 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN LEFT EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Left Ear												
Boys												
500	27	-0.25	47	0.03	46	0.04	47	0.11	89	-0.09	80	0.09
1000	29	-0.09	47	0.08	50	0.08	47	0.21	89	-0.10	80	0.18
2000	33	-0.33	48	0.09	50	0.33*	48	0.21	89	-0.04	80	0.04
4000	30	-0.38*	48	0.16	50	0.26	48	0.10	89	0.01	80	-0.05
6000	28	-0.39*	47	-0.05	50	-0.04	48	0.02	89	0.10	80	-0.07
M512	27	-0.17	47	0.11	46	0.14	47	0.23	89	-0.10	80	0.13
D4	29	0.18	47	-0.21	50	-0.11	47	0.00	89	-0.06	80	0.18
Girls												
500	21	-0.37	42	0.27	42	-0.23	58	0.18	102	-0.02	67	0.09
1000	23	-0.18	43	0.31*	43	-0.17	58	0.07	102	-0.08	67	-0.08
2000	24	-0.16	44	0.05	43	-0.36*	57	0.08	102	-0.16	67	0.11
4000	23	-0.42*	43	0.15	42	-0.41**	58	0.22	102	0.12	67	0.03
6000	22	-0.17	43	0.02	43	-0.19	58	0.19	102	-0.15	67	0.03
M512	21	-0.30	42	0.26	42	-0.27	57	0.09	102	-0.09	67	0.07
D4	22	0.24	42	0.01	42	0.20	58	-0.12	102	-0.13	67	-0.06

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 107 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN BETTER EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Better Ear												
Boys												
500	33	-0.25	49	0.01	51	-0.11	49	0.03	89	-0.14	80	0.08
1000	33	-0.24	49	0.20	51	-0.08	49	0.07	89	-0.02	80	0.04
2000	33	-0.34*	49	0.12	51	0.32*	49	0.18	89	-0.04	80	-0.12
4000	33	-0.18	49	0.10	51	0.14	49	0.20	89	-0.02	80	-0.08
6000	33	-0.42	49	0.19	51	-0.04	49	0.12	89	0.01	80	-0.01
M512	33	-0.38*	49	0.09	51	0.08	49	0.14	89	-0.11	80	0.01
D4	33	0.03	49	0.01	51	-0.17	49	-0.16	89	-0.09	80	0.10
Girls												
500	28	-0.11	45	0.23	44	-0.34*	58	0.15	102	0.01	67	0.08
1000	30	0.06	47	0.20	44	-0.23	59	0.04	102	-0.04	67	-0.10
2000	31	0.23	47	0.17	44	-0.33*	59	0.10	102	-0.05	67	0.08
4000	29	-0.17	47	0.15	44	-0.31*	59	0.18	102	0.08	67	0.13
6000	28	0.16	47	0.06	44	-0.13	59	0.11	102	-0.13	67	0.00
M512	28	0.01	45	0.23	44	-0.33*	58	0.12	102	0.00	67	-0.03
D4	28	0.20	47	0.01	44	0.15	59	-0.12	102	-0.04	67	-0.21

* $.01 < p \leq .05$

TABLE 108 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN WORSE EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Worse Ear												
Boys												
500	25	-0.27	47	-0.01	45	-0.17	47	0.11	89	-0.10	80	0.03
1000	27	-0.16	47	-0.09	50	0.04	47	0.31*	89	-0.08	80	0.16
2000	33	-0.32	48	-0.10	50	0.24	48	0.09	89	-0.01	80	0.00
4000	30	-0.31	48	0.03	50	0.12	48	0.12	89	0.11	80	-0.05
6000	28	-0.14	47	-0.14	50	0.10	48	-0.04	89	0.17	80	-0.11
M512	25	-0.22	47	-0.10	45	-0.02	47	0.21	89	-0.07	80	0.11
D4	27	0.14	47	-0.15	50	-0.11	47	0.05	89	-0.16	80	0.14
Girls												
500	21	-0.09	42	0.29	42	-0.22	58	0.21	102	-0.01	67	-0.02
1000	23	-0.14	43	0.15	43	-0.21	58	0.04	102	0.00	67	-0.15
2000	24	-0.10	44	-0.04	43	-0.46**	57	-0.05	102	-0.11	67	-0.05
4000	23	-0.41*	43	0.29	42	-0.58**	58	0.04	102	0.13	67	-0.04
6000	22	-0.20	43	-0.09	43	-0.49**	58	0.19	102	-0.13	67	0.05
M512	21	-0.14	42	0.15	42	-0.36*	57	0.07	102	-0.04	67	-0.04
D4	22	0.35	42	-0.14	42	0.19	58	-0.05	102	-0.13	67	-0.03

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 109 - DESCRIPTIVE STATISTICS FOR AUDITORY THRESHOLD LEVELS AT 4000 Hz IN GROUPS EXPOSED AND NOT EXPOSED TO SPECIFIC NOISE EVENTS

Event	Difference $\bar{X}_e - \bar{X}_u$	Exposed $\bar{X}_e$	Exposed s.d.	Exposed n	Unexposed $\bar{X}_u$	Unexposed s.d.	Unexposed n
Fireworks	0.13	-0.67	7.08	180	-0.80	7.19	519
Loud radio	-0.45	-1.12	6.76	154	-0.67	7.27	545
Flight pattern	-1.24	-2.00	-	2	-0.76	7.17	697
Power tools	1.02 **	-0.35	6.94	412	-1.37	7.43	287
Near Firearms	0.02	-0.75	7.20	133	-0.77	7.15	566
Farm machines	.53 *	-0.35	7.45	155	-0.88	7.07	544
Loud T.V.	1.39 **	0.43	6.62	98	-0.96	7.22	601
Amplified inst.	-1.83 **	-2.50	6.30	36	-0.67	7.19	663
Loud vehicles	0.99 **	-0.13	6.24	248	-1.12	7.60	451
Bus	-0.09	-0.87	7.06	428	-0.78	7.30	260

* $.01 < p \leq .05$

** $p \leq .01$

vehicles are consistent with a hypothesis of noise induced hearing loss associated with these events. Nevertheless, those exposed to amplified instruments have lower thresholds than those unexposed to the same event.

It should be recalled that there are definite age trends in exposure to some of these noise events (Figures 46 and 47) and in the thresholds (Tables 8 and 34); consequently, the results in Table 109 may reflect differing age composition in the exposed and unexposed samples, rather than a noise effect per se.

It may be argued that while the mean thresholds of those exposed to a noise event do not differ from those of unexposed individuals, the individuals at the extremes of the distributions of each of these groups may differ considerably. Therefore, in Figures 50 through 53 are presented the medians and 95th percentiles of auditory thresholds in the better and worse ears at 4000 Hz within two age groups. It is clear that the direction of differences between median thresholds is not always the same as that between the 95th percentiles. In the better ear (Figures 50 and 51) there are few marked differences between the 95th percentile thresholds of the exposed and unexposed groups, although exposure to farm machinery in 6-11-year-olds, and loud vehicles, power tools, and bus in 12-17-year-olds seem to be associated with relatively higher 95th percentile thresholds than in the unexposed group.

For the worse ear (Figures 52 and 53), the situation is less clear, with unexposed individuals having higher thresholds as often as the exposed individuals.

The previous analyses of noise events have examined associations with single events only. Because this is reflective of a child's real noise exposure, scores of noise were derived from factor analysis representing differentially weighted clusters of mean event scores, based on a child's exposure to these events. The orthogonal groupings of noise events into five factors and their loadings on that factor are presented in Table 110. Correlations between event factor scores and worse ear auditory thresholds are presented in Table 111. For ease of reference, the factors have been named representing chief sources of noise. All of the correlations are low, but in girls, there are significant positive correlations with thresholds and Factors 1, 2 and 4, and in boys, Factor 5. This indicates as the aggregate noise of these event factors increase, thresholds rise, suggesting noise-induced hearing loss for exposed individuals. The opposite is generally true in boys, with significant negative correlations of noise with Factors 1, 3 and 4. The sex difference may result from differing age composition of the boys and girls.

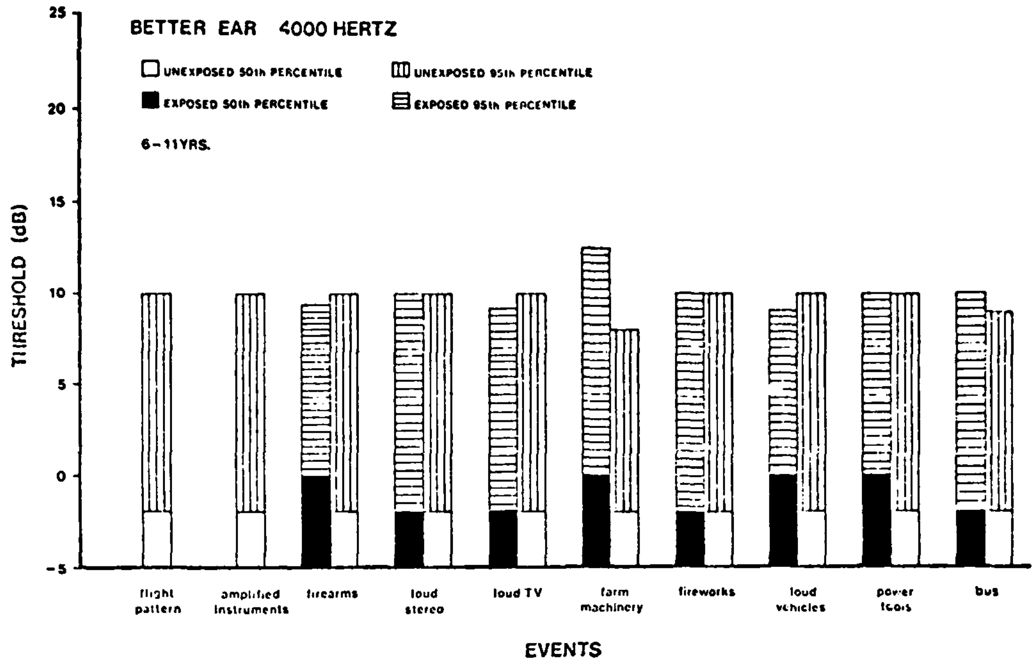

FIGURE 50 -BETTER EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND 95TH PERCENTILES AT 4000 Hz IN 6-11 YEAR OLDS EXPOSED TO SPECIFIC NOISE EVENTS

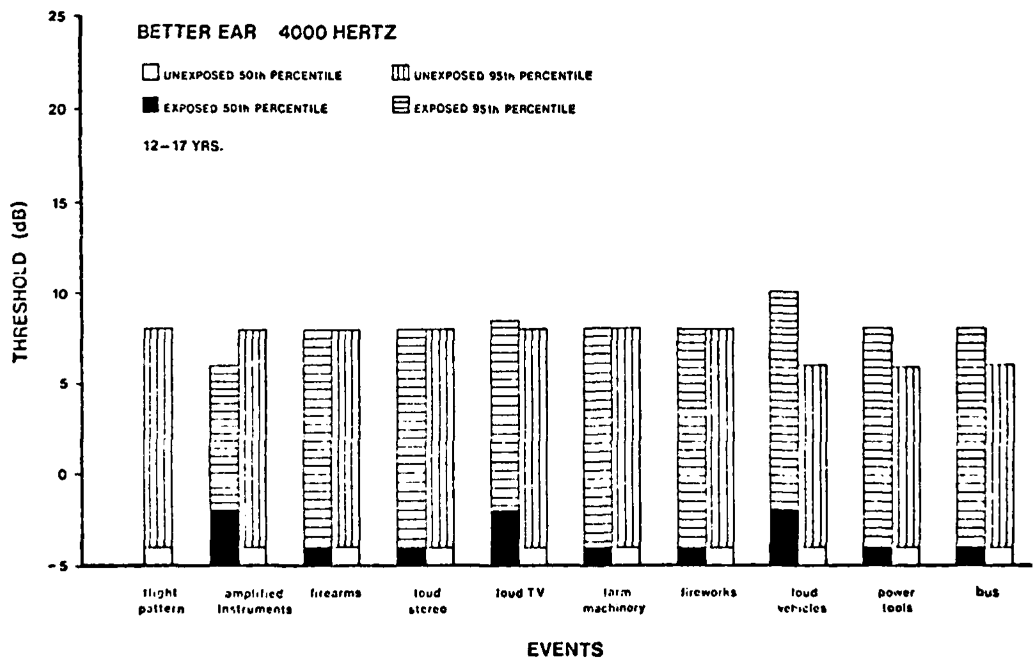

FIGURE 51 -BETTER EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND 95TH PERCENTILES AT 4000 Hz IN 12-17 YEAR OLDS EXPOSED TO SPECIFIC NOISE EVENTS

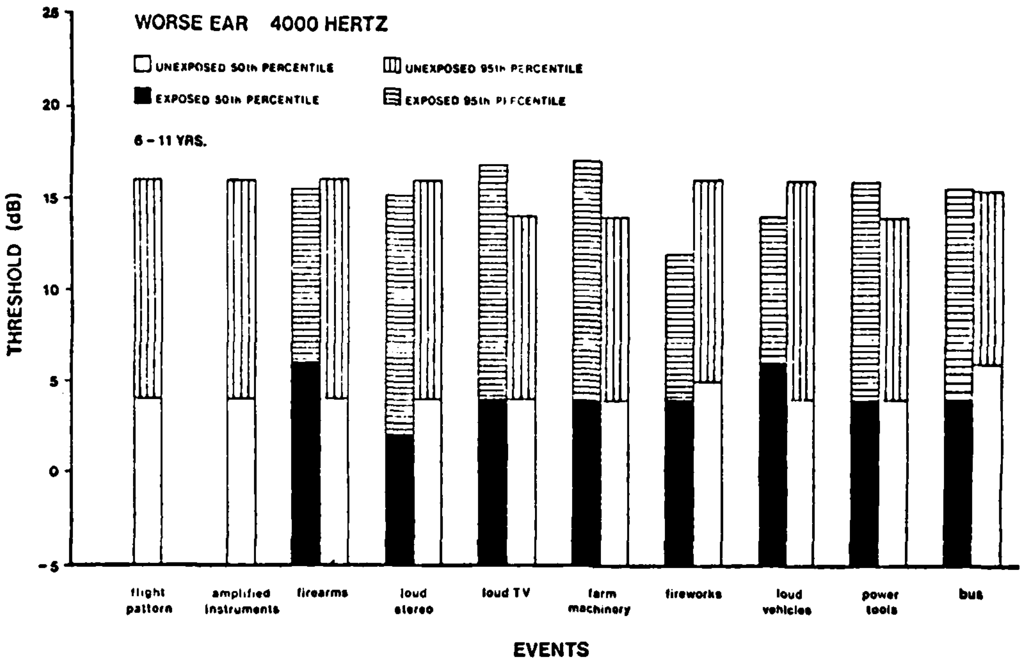

FIGURE 52 -WORSE EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND 95TH PERCENTILES AT 4000 Hz IN 6-11 YEAR OLDS EXPOSED TO SPECIFIC NOISE EVENTS

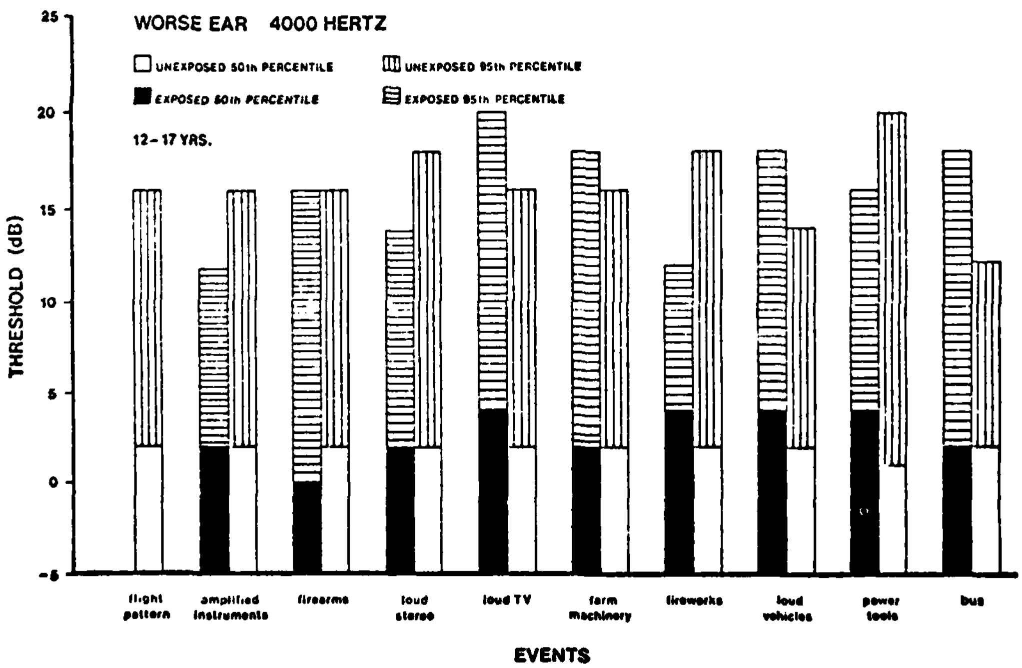

FIGURE 53 -WORSE EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND 95TH PERCENTILES AT 4000 Hz IN 12-17 YEAR OLDS EXPOSED TO SPECIFIC NOISE EVENTS

TABLE 110 - FACTOR ANALYSIS OF MEAN EVENT SCORES WITH VERIMAX (ORTHOGONAL) ROTATION

FACTOR 1		FACTOR 2		FACTOR 3	
Farm machinery	(.71)	Loud T.V.	(.93)	Amp. instrument	(.92)
Firearms	(.68)				
Power tools	(.59)				
Loud vehicles	(.51)				

FACTOR 4		FACTOR 5	
Loud radio	(.71)	Flight patterns	(.99)
Fireworks	(.68)		

Correlations were calculated between the same noise event factor scores and the 6-month threshold increments (Table 112). The correlations are all effectively zero, and the single significant coefficient (boys' D4 and Factor 1) is to be expected by chance alone.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS, BLOOD PRESSURE AND NOISE

Correlations between auditory thresholds and blood pressure were calculated for all ages combined (Table 113). The coefficients are near zero in boys and in girls there are significant and negative correlations for better ear and worse ear that are about the same at all thresholds. When the effects of age were removed from both variables, the general pattern changed (Table 114). The coefficients with systolic pressure tend to be positive and significant in the boys but negative and significant in the girls. The coefficients are not large (none exceed 0.2) but the effects are similar for the better and the worse ear. All the correlations with diastolic pressure are near zero.

TABLE 111 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN WORSE EAR AUDITORY THRESHOLD AND FIVE EVENT NOISE FACTORS

Frequency (Hz)	Factor 1 Machinery	Factor 2 Loud TV	Factor 3 Amp. Instrument	Factor 4 Loud Radio Fire wks.	Factor 5 Flight Pattern
Boys (n=513)					
500	-0.04	0.03	-0.03	-0.15 **	0.14 **
1000	-0.05	0.08	-0.01	-0.07	0.10 *
2000	0.00	-0.01	-0.06	-0.09 *	0.00
4000	0.06	0.07	-0.09 *	-0.08	0.03
6000	0.08	0.01	0.02	-0.14 **	0.06
M512	-0.04	0.04	-0.04	-0.14 **	0.10 *
D4	-0.12 **	0.03	0.10 *	0.01	0.09 *
Girls (n=489)					
500	0.05	0.10 *	-0.03	0.08	0.00
1000	0.04	0.08	0.03	0.04	0.01
2000	0.09 *	0.06	-0.09	0.02	-0.01
4000	0.10 *	0.05	-0.05	0.04	-0.04
6000	0.13 **	0.09	-0.06	0.10 *	0.01
M512	0.07	0.09 *	-0.02	0.05	0.00
D4	-0.08	0.01	0.08	-0.03	0.04

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 112 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN WORSE EAR AUDITORY THRESHOLD INCREMENTS AND FIVE EVENT SCORE FACTORS

Frequency (Hz)	Factor 1 Machinery	Factor 2 Loud TV	Factor 3 Amp: Instrument	Factor 4 Loud Radio Fire wks.	Factor 5 Flight Pattern
Boys (n=358)					
500	0.05	-0.05	0.03	-0.03	0.03
1000	-0.04	0.09	-0.03	0.03	0.06
2000	0.01	-0.01	0.02	-0.06	0.01
4000	0.09	0.04	-0.08	0.03	-0.02
6000	0.05	0.04	0.09	-0.01	0.02
M512	0.02	0.03	0.01	-0.03	0.04
D4	-0.13 *	0.00	0.05	-0.02	0.06
Girls (n=346)					
500	0.09	0.07	-0.04	0.05	-0.03
1000	0.04	-0.03	-0.01	-0.05	-0.01
2000	0.08	0.00	0.06	0.00	0.00
4000	0.03	0.01	-0.06	-0.06	-0.02
6000	0.06	0.02	-0.03	-0.04	-0.03
M512	0.07	0.02	0.01	-0.01	-0.02
D4	0.00	-0.04	0.05	0.01	0.01

* $.01 < p \leq .05$

TABLE 113 - SPEARMAN RANK CORRELATION COEFFICIENTS (rs) BETWEEN AUDITORY THRESHOLDS AND SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE IN BOYS AND GIRLS

Frequency (Hz)	Boys (n=275) Systolic	Boys (n=275) Diastolic	Girls (n=276) Systolic	Girls (n=276) Diastolic
Better ear				
500	-0.10	-0.16 **	-0.33 **	-0.16 **
1000	-0.07	-0.09	-0.27 **	-0.12 *
2000	0.01	-0.04	-0.28 **	-0.15 *
4000	-0.01	-0.08	-0.25 **	-0.15 *
6000	-0.04	0.00	-0.24 **	-0.15 *
M512	-0.08	-0.12 *	-0.34 **	-0.17 **
D4	-0.11	-0.05	0.05	0.07
Worse ear	Boys (n=271)		Girls (n=268)	
500	-0.04	-0.15 *	-0.31 **	-0.15 *
1000	-0.03	-0.07	-0.27 **	-0.16 *
2000	0.01	-0.03	-0.25 **	-0.15 *
4000	0.03	-0.01	-0.25 **	-0.17 **
6000	0.00	-0.02	-0.18 **	-0.08
M512	-0.02	-0.11	-0.32 **	-0.16 **
D4	-0.10	-0.07	0.00	0.04

* $.01 < p \leq .05$

** $p < .01$

TABLE 114 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN AUDITORY THRESHOLDS AND SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=275) Systolic	Boys (n=275) Diastolic	Girls (n=276) Systolic	Girls (n=276) Diastolic
Better ear				
500	0.06	-0.09	-0.16 **	-0.06
1000	0.11	-0.02	-0.10	-0.03
2000	0.15 *	0.02	-0.10	-0.06
4000	0.14 *	-0.03	-0.10	-0.07
6000	0.09	0.05	-0.12	-0.09
M512	0.10	-0.05	-0.16 **	-0.06
D4	-0.09	-0.03	0.05	0.08
Worse Ear	Boys (n=271)		Girls (n=268)	
500	0.08	-0.10	-0.16 **	-0.05
1000	0.13 *	-0.01	-0.15 *	-0.08
2000	0.18 **	0.03	-0.12	-0.06
4000	0.14 *	0.03	-0.13 *	-0.09
6000	0.09	0.00	-0.10	-0.04
M512	0.15 *	-0.05	-0.17 **	-0.06
D4	-0.06	-0.05	-0.02	0.04

* $.01 < p \leq .05$

** $p \leq .01$

Other correlations were calculated using the means across age for the thresholds and blood pressures within individuals (Table 115), in an attempt to minimize measurement error. None of these coefficients is significant in the boys. There are consistently negative coefficients in the girls and many of these are significant, especially those with systolic pressure. These correlations were run also after removing the effects of age from each variable (Table 116). The effects of partialling out age was marked. After this procedure, none of the coefficients for girls are significant although almost all remained negative. Those for the boys are near zero for diastolic pressure but those for systolic pressure are nearly all positive and most are significant. These findings indicate that boys with high systolic pressures tend to have high auditory thresholds although there are no corresponding associations in girls or with diastolic pressure.

Correlations were calculated also between blood pressures and noise scores for all ages combined (Table 117). These are positive and significant for systolic pressure in each sex, but near zero for diastolic pressure. However, when the effects of age are removed from each variable, the correlations are near zero (Table 118).

Corresponding correlations were calculated using the means of serial blood pressures and serial noise scores for individuals. The correlations between these mean scores and pressures are significant for boys but not girls (Table 119). However, when the effects of age are removed from both variables, the coefficents are not significant and they have values near zero (Table 120).

In summary, after removing the effects of age, auditory thresholds and systolic blood pressure tend to be significantly correlated in each sex but positively in boys and negatively in girls. The correlations with diastolic pressure are near zero. Similar findings were obtained when the means of values across age within individuals were used in the correlations. The correlations between blood pressures and noise scores are not significant.

DOSIMETRY

Noise exposure (Leq_{24}) was measured by dosimetry in 100 participants (47 boys; 53 girls). Table 121 gives the descriptive statistics for Leq_{24} in these participants. There was no significant sex difference for Leq_{24}; however, the range of exposure was slightly greater in females, due to more values at lower levels. The sexes did not differ in age (mean about 14.3 years, s.d. 2.9 years). Figure 54 presents a plot of Leq_{24} versus age; linear regression analysis indicated there is no significant change in Leq_{24} with age in either sex.

TABLE 115 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE AND MEAN AUDITORY THRESHOLDS

Frequency (Hz)	Boys (n=72) Systolic	Boys (n=72) Diastolic	Girls (n=72) Systolic	Girls (n=72) Diastolic
Better Ear				
500	-0.01	-0.12	-0.37 **	-0.28 *
1000	0.09	-0.01	-0.25 *	-0.21
2000	0.07	-0.02	-0.27 *	-0.23
4000	0.09	-0.10	-0.22	-0.10
6000	-0.02	0.03	-0.29 *	-0.11
M512	0.02	-0.10	-0.33 **	-0.24 *
D4	-0.09	0.04	-0.02	-0.12
Worse Ear				
500	0.08	-0.09	-0.29*	-0.23 *
1000	0.12	0.00	-0.24 *	-0.17
2000	0.04	-0.08	-0.24 *	-0.20
4000	0.09	-0.09	-0.15	-0.20
6000	-0.02	0.01	-0.21	-0.06
M512	0.07	-0.09	-0.31 **	-0.21
D4	-0.06	-0.01	-0.03	0.04

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 116 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURES AND MEAN AUDITORY THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=72) Systolic	Boys (n=72) Diastolic	Girls (n=72) Systolic	Girls (n=72) Diastolic
Better Ear				
500	0.27 *	-0.05	-0.17	-0.19
1000	0.37 **	0.06	-0.05	-0.10
2000	0.24 *	0.01	-0.05	-0.07
4000	0.27 *	-0.06	-0.08	0.00
6000	0.13	0.09	-0.20	-0.02
M512	0.29 *	-0.04	-0.13	-0.11
D4	-0.06	0.07	0.04	-0.09
Worse Ear				
500	0.32 **	-0.02	-0.13	-0.16
1000	0.36 **	0.04	-0.06	-0.06
2000	0.24 *	-0.04	-0.06	-0.09
4000	0.19	-0.08	-0.03	-0.09
6000	0.13	0.05	-0.15	0.05
M512	0.30 *	-0.07	-0.14	-0.13
D4	0.06	0.06	0.01	0.04

* $.01 < p \leq .05$

** $p < .01$

TABLE 117 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE AND INTERVAL NOISE SCORES

	Boys (n=251)	Girls (n=259)
Systolic	0.35 **	0.19 **
Diastolic	0.08	0.05

** $p \leq .01$

TABLE 118 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE AND INTERVAL NOISE SCORES WITH THE EFFECT OF AGE PARTIALLED FROM BOTH

	Boys (n=251)	Girls (n=259)
Systolic	0.12	0.12
Diastolic	-0.01	0.02

TABLE 119 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE AND MEAN INTERVAL NOISE SCORES

	Boys (n=70)	Girls (n=70)
Systolic	0.47 **	0.12
Diastolic	0.26 *	0.22

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 120 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE AND MEAN INTERVAL NOISE SCORES WITH THE EFFECT OF AGE PARTIALLED FROM BOTH

	Boys (n=70)	Girls (n=70)
Systolic	0.10	-0.09
Diastolic	0.04	0.09

TABLE 121 - DISTRIBUTION STATISTICS FOR NOISE EXPOSURE (Leq_{24}) MEASURED WITH DOSIMETERS

	n	$\bar{x}$	s.d.	range	
Boys	47	83.1	5.6	73.0	99.4
Girls	53	82.0	7.2	58.8	102.4
Both Sexes	100	82.5	6.5	58.8	102.4

Four different dosimeters were used at various times during this study. They were Loomis Laboratories (model 3573), Bruel and Kjaer (model 4424), General Radio (model 1954-9780), and Metrosonics (model dB 301). Currently, we are using the latter two. An analysis of variance coupled with Duncan's multiple range test indicated significant differences among dosimeters. As shown in Table 122, the General Radio dosimeter recorded significantly higher mean Leq_{24} values than the others.

Table 123 presents the means and standard deviations of the left ear auditory thresholds (in dB) for the boys and girls for whom there are dosimetry data. There is no significant difference between the sexes in auditory thresholds at any frequency; however, at every frequency except 6000 Hz, the variance of auditory thresholds is greater for females than males. This is no doubt a sampling artifact, as there is no indication of sex-associated difference in variance in the total sample of children.

The relationship between Leq_{24} and auditory thresholds in the left ear at 1000, 2000, 4000 and 6000 Hz was investigated using Spearman rank correlation coefficients. There is no significant correlation between Leq_{24} and any threshold in the boys. However, in the girls, Leq_{24} and auditory threshold at 4000 Hz are significantly correlated ($r = 0.29$, $p = .04$). The slope of the linear regression line of Leq_{24} on threshold at 4000 Hz indicates an increase of 0.46 dB in auditory threshold for each dB increase in Leq_{24}. This is an interesting finding; however, before too much importance is attached to it, it must be verified in a larger sample.

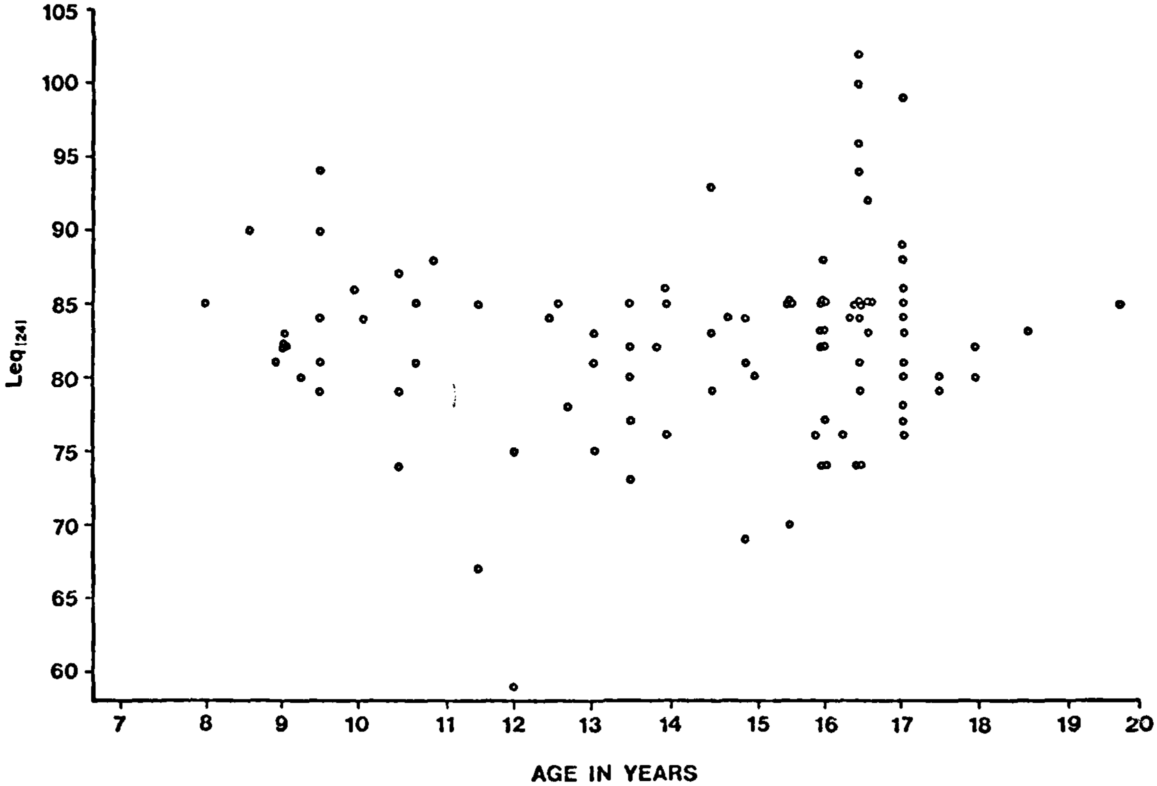

FIGURE 54 -PLOT OF $Leq_{(24)}$ RELATIVE TO AGE IN YEARS

TABLE 122 - F VALUES FROM ANALYSIS OF VARIANCE AND RESULTS OF DUNCAN'S MULTIPLE RANGE TEST FOR DIFFERENCES AMONG DOSIMETERS

	Both Sexes			Boys			Girls		
	n	$\bar{x}$	DMR[1]	n	$\bar{x}$	DMR[1]	n	$\bar{x}$	DMR[1]
General Radio	72	84.4		33	84.6		39	84.1	
Bruel and Kjaer	10	78.6		6	79.2		4	77.8	
Metrosonics	2	78.0		--	----		2	78.0	
Loomis Laboratory	16	76.9		8	79.3		8	74.6	
F Ratio	9.26*			5.58**			5.87**		

* $.01 < p \leq .05$

** $p \leq .01$

[1]Duncan's Multiple Ranges. There are no significant differences between the values joined by vertical lines.

TABLE 123 - AUDITORY THRESHOLD LEVELS (dB) IN THE LEFT EAR OF 43 BOYS AND 53 GIRLS WHO PARTICIPATED IN THE MEASUREMENT OF 24-HOUR NOISE EXPOSURE (Leq_{24}) USING PORTABLE DOSIMETERS

	Boys		Girls		Both Sexes	
Frequency	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
1000 Hz	-4.6	5.3	-1.8	12.0	-3.1	9.7
2000 Hz	-6.0	6.7	-2.8	11.5	-4.3	9.7
4000 Hz	-2.8	6.8	-.73	12.5	-1.7	10.3
6000 Hz	-2.2	9.0	-.53	11.0	-1.3	10.2

CONCLUSION

Environmental noise may have adverse effects on the auditory thresholds of people of all ages but there are convincing reasons why the hearing of children should be examined with particular care. Further, serial studies offer several advantages over cross-sectional studies. The major reasons why serial studies of auditory thresholds in children are needed are:

1. Children may be more susceptible to noise damage than adults.

2. Children may be exposed to different sources of noise than adults; some of these may not be recognized currently as influencing hearing.

3. Hearing loss in a child may have more severe effects on learning and communication than a similar loss in an adult.

4. Hearing thresholds during childhood may be correlated with hearing ability in adult life.

5. Some effects found in cross-sectional studies may not be general trends in all individuals, but either artifacts of sampling or reflect marked changes in subgroups.

6. A longitudinal study is the only way to determine whether the effect of noise on an individual's hearing is temporary or permanent.

7. A longitudinal study, especially in children, allows one to examine the effect of developmental and growth changes on hearing levels, and to separate these from environmental effects.

8. There may be critical periods when hearing sensitivity is prone to change and serial study is necessary to document and evaluate these changes.

9. To determine if there are changes in peripheral blood pressure that may be related to noise exposure and hearing loss.

This multi-year serial study was undertaken because of the factors enumerated above and because so little is known about environmental and developmental effects on hearing in children. Since the findings reported here represent only the first three years of data collection, the findings should be considered preliminary; the study is only beginning to meet its full potential. Furthermore, because relatively few of the participants in the study had suitable multiple measurements of auditory thresholds, most of the present analyses are cross-sectional rather than longitudinal.

The group constituting the Fels sample has relatively good hearing. The mean and median thresholds at almost all frequencies are 2 to 6 dB lower than those from United States national surveys (Roberts and Federico, 1970; Roberts and Ahuja, 1975) for children of corresponding ages. Probably these differences reflect dissimilarities between the Fels and national samples in many aspects, e.g., geographical, socio-economic, racial factors.

There are indications that some abnormal otological findings may be associated with hearing losses. Also of interest are analyses of auditory thresholds in relation to body size and sexual and skeletal maturity. There is a suggestion of possible developmental correlates because the auditory thresholds decrease during adolescence, especially in girls. Rapidly maturing children tend to have lower thresholds than others although the picture is not entirely clear.

Consistent and sometimes large lateral differences in thresholds occurred. These may be due to testing procedures or, perhaps, represent biological differences; further studies are needed to clarify this. Lateral differences are not present in the increments, which suggests that these differences are likely to be due to testing artifacts.

The older group of children (12 to 17-year-olds) had lower thresholds than the younger group (6 to 11-year-olds): a much larger proportion of the older children were hearing at the lowest possible limit of the audiometer. In addition, there is a significant negative correlation between age and thresholds. This may mean younger children cannot perform the testing task well enough to reach their "true" thresholds; an alternative explanation is that hearing ability may improve during the middle childhood years.

Auditory thresholds tend to be higher at 4000 and 6000 Hz than at the other frequencies tested in each group examined. Similarly, at these frequencies, the mean 6-month increments in thresholds are consistently larger (decline in hearing ability) than at lower frequencies. This finding is consonant with the view that noise might be important with regard to auditory thresholds of children. The higher frequencies (especially 4000 Hz) are the more sensitive to damage by noise, whether permanent or temporary threshold shifts are considered. Therefore, the higher initial thresholds and larger increments at higher frequencies may result from noise exposure.

In general, girls have slightly lower mean thresholds than boys and less variation in threshold measurements at a given age. This may reflect differences in behavior resulting in less noise exposure, and, therefore, less hearing loss due to noise exposure. This explanation is supported by the fact

that threshold differences between boys and girls are larger in the 12- to 17-year-olds than in the 6- to 11-year-olds. Moreover, the median total noise exposure scores show a marked sex difference only in the older group, with boys having the higher total noise exposure. Therefore, if noise is having an adverse effect, older boys should have higher thresholds. This hypothesis is consistent with the present data. Finally, the 6-month increments are larger, in the direction of hearing loss, in the older group and more pronounced in boys. Because the thresholds of girls tend to be lower and less variable than those of boys, the sex differences may reflect less noise exposure in the girls. Certainly the trend of increasing sex differences in mean thresholds with age is in accordance with the trend of increasing sex differences in noise exposure although the correlations between noise exposure scores and auditory thresholds were not significant.

It is clear that participants in the study have a wide range of noise exposure and a wide range of sources of this noise. The noise exposure histories of many participants suggest high levels of noise exposure. The current quantification procedure applied to the noise exposure histories is imprecise. However, the concept should be retained because it allows comparisons that are very difficult to make qualitatively. While the quantitative noise exposure scores from the interval and total noise exposure histories are important measures of noise exposure, the formula by which they are derived may be modified in the future. Empirical modifications based on the distributions of each question score, and relationships with the data from other questions concerning noise, and further dosimeter studies will be helpful in this regard.

The qualitative approach allows the identification of specific noise events that may be significant biologically; therefore, it is very important. The various data concerning noise exposure indicate fireworks and being near firearms were not problems in this sample with respect to noise-induced hearing loss, although the potential for considerable loss from the use of firearms has been demonstrated in other studies. Loud stereo, hi-fi, or radio; loud vehicles; loud television, riding a school bus, and power tools may be associated with some elevation of auditory thresholds in the present sample; such findings in these noise categories indicate the need for further investigation.

The major long-term aims of this study are to determine the pattern of auditory threshold levels in children and to relate changes in these thresholds to developmental and environmental events (particularly noise exposure). While it is too early in the study to establish patterns or unequivocally relate changes to specific events, it is clear from the preliminary findings that the design, sample, and methodology of the study are ideally suited for the attainment of these long-term aims. The preliminary findings of sex and age effects, as well as relationships among thresholds, increments, noise exposure and other related measurements, only hint at the potential of this study to answer important questions that relate to human hearing.

APPENDIX A

Additions to "Interval Audiometry Questionnaire" (Appendix C of AMRL-TR-76-110; Roche et al., 1977) begun in September, 1977.

37. Do you ride a school bus to school?

☐ no D72 ☐ yes D73

a) One way? ☐ D74

b) Both ways? ☐ D75

c) Number of days each week? ☐ D76

d) About how many minutes does the ride last one way? ☐☐ D77-78

38. Were auditory thresholds tested on the same day that underwater weighing was done?
0 = no 1 = yes

☐ D79

☐ D80

CARD E- col. 1-7 same as D

5 E8

39. Have your habits with regard to riding a bus to school changed since January, 1976? (Please provide details.)

☐ no E9 ☐ yes E10

40. (For any Participant not having UGG measurments.)

Blood Pressure:

1. ____/____/____

2. ☐☐☐/☐☐☐/☐☐☐ E 11 12 13 / E 14 15 16 / E 17 18 19

3. ☐☐☐/☐☐☐/☐☐☐ E 23 24 25 / E 26 27 28 / E 29 30 31

Heart rate/min. :

____

☐☐☐ E 20 21 22

☐☐☐ E 32 33 34

☐ E 80

Fels Research Institute

APPENDIX B

Study No. R805

General Radio Dosimeter Form

Participant Name		
Participant No.		
Clan No.		
Test Duration	:	
Participant Residence		1=rural, 2=non-rural
Dosimeter Type 4=GenRad	4	
Dosimeter No.		
Date Test Start	- - 7 9	
Data 1=good, 2=bad		
Range		1=60-110dB, 2=80-130dB
Capacity Filled 1=yes, 2=no		
Typical Day 1=yes, 2=no		
If no: 1=louder, 2=quieter, if yes:0		

Participant Age (years)	.	
Participant Birthdate	- -	
Participant Sex 1=m, 2=f		
Left Ear Hearing 1000 Hz		
Thresholds at 2000 Hz		
Nearest Date 4000 Hz		
6000 Hz		
Leq(24)	.	
Allowable Level Exceeded		1=yes, 2=no
Thresholds Date	- -	
Calibration Level	116.5dB at 1000Hz	Calibrations:
Calibration Time	10 seconds	Before After
Measurement Reading	.	1.
Battery Check 1=good, 2=low		2.
Range Check 1=same, 2=not same		3.
Time Start Test	:	4.
Time End Test	:	5.
Activities, sources of noise		Av.
		Tot.

Dosimeter Pick-Up Instructions

Fels Research Institute

APPENDIX C

Study No. R805

Metrosonics Dosimeter Form

Participant Name	
Participant No.	
Clan No.	
Test Duration	:
Participant Residence	1=rural, 2=non-rural
Dosimeter Type 5=Metrosonics	5
Dosimeter Serial No.	1 1 1 3
Date Test Start	7 9
Data 1=good, 2=bad	
Range 3=60-124dB	3
Capacity Filled 0=not appl.	0
Typical Day 1=yes, 2=no	
If no: 1=louder, 2=quieter; if yes: 0	

Participant Age (years)	
Participant Birthdate	
Participant Sex 1=m, 2=f	
Left Ear Hearing 1000 Hz	
Thresholds at 2000 Hz	
Nearest Date 4000 Hz	
6000 Hz	
$Leq_{(24)}$	
Allowable Level Exceeded 0=not appl.	0
Hearing Thresholds Date	
Calibration Level	114 dB at 1000 Hz
Calibration Before Test	1=calibrated
Calibration After Test	1=calibrated, 2=off
Battery Check 1=good, 2=low	
Time Start Test	:
Time End Test	:

Activities, sources of noise

Dosimeter Pick-Up Instructions

REFERENCES

Andrukovich, A. I. 1965 Effect of industrial noise in winding and weaving factories on arterial pressure in the operators of the machines (Russian). Gigiena Truda i Professional 'nye Zabolevaniya, 9: 39-42. (Cited by Welch, 1978)

Barr, B., and E. Wedenberg 1965 Prognosis of perceptive hearing loss in children with respect to genesis and use of hearing aid. Acta Oto-Laryngol., 59: 462-474.

Bess, F. H., and R. L. Powell 1972 Hearing hazard from model airplanes. A study on their potential damaging effects to the auditory mechanism. Clin. Pediat., 11: 621-624.

Bess, F. H., and R. E. Poynor 1972 Snowmobile engine noise and hearing. Arch. Otolaryng., 95: 164-168.

Black, M. E. 1939 Audiometric norms for determining hypacusia in children between ages 4 and 8. J. Speech Disord., 5: 2-14.

Bordley, J. E., and W. G. Hardy 1955 The efficacy of nasopharyngeal irradiation for the prevention of deafness in children. Acta Oto-Laryng., Suppl. 120, pp. 1-49.

Burnap, W. L. 1929 Sense of hearing survey of school children in Fergus Falls. Minn. Med., 12: 691-693.

Carter, N. L., V. G. Bulteau, C. H. Gray, L. Macsween, and and M. Ferris 1975 National Acoustic Laboratories Report No. 63. Report of a study on the effects of environmental noise on children's hearing. Australian Department of Health, National Acoustic Laboratories, Sydney, Australia.

Carter, N. L., K. Keen, R. L. Waugh, and V. G. Bulteau, Eds., 1978 National Acoustic Laboratories Report No. 70. Hearing Levels of 10-12 Year Old Sydney Schoolchildren. Australian Department of Health, National Acoustic Laboratories, Sydney, Australia, 327 pp.

Carter, N. L., L. Macsween, V. G. Bulteau, C. H. Gray, and M. Ferris 1976 Environmental noise and pure tone thresholds. Sound and Vibr., 46: 259-278.

Chemin, Ph., Bramerie, Y., and A. Chemin 1970 Noise. Its physiopathological consequences. The problems of protection of the exposed personnel. Rev. Hyg. et Med. Soc., 18: 519-534.

Ciocco, A., and C. E. Palmer 1941 The hearing of school children. A statistical study of audiometric and clinical records. Monogr. Soc. Res. Child Develop., 6: No. 3. 77 pp.

Clark, A. D., and C. J. Richards 1966 Auditory discrimination among economically disadvantaged and nondisadvantaged preschool children. Except. Child., 33: 259-262.

Cohen, S., D. C. Glass, and J. E. Singer 1973 Apartment noise, auditory discrimination, and reading ability in children. J. Exp. Soc. Psychol., 9: 407-422.

Cozad, R. L., L. Marston, and D. Joseph 1974 Some implications regarding high frequency hearing loss in school-age children. J. School Health, 44: 92-96.

Curry, E. T. 1950 Analysis of hearing loss patterns in a rural Illinois school system. Am. J. Dis. Child., 80: 254-259.

Eagles, E. l., S. M. Wishik, L. G. Doerfler, W. Melnick, and H. S. Levine 1963 Hearing sensitivity and related factors in children. Laryngoscope, Monograph Suppl., 1-143.

Eagles, E. L., S. M. Wishik, and L. G. Doerfler 1967 Hearing sensitivity and ear disease in children: A prospective study. Laryngoscope, Monograph Suppl., 2-26.

Fakhre, A. G., H. Soliman, M. A. Hamid and M. A. Sarhan 1976 Presbycusis in relation to hypertension in low-noise surroundings.pp 31-36 in Report of a Special Conference on Hearing Threshold Levels of "Isolated" Human Populations. National Research Council, Canada, No. 16738, Ottawa

Fentem, P. H., and I. Shakir 1977 Vibration, blood pressure and heart rate. Physiotherapy, 63: 364-365.

Fior, R. 1972 Physiological maturation of auditory function between 3 and 13 years of age. Audiology, 11: 317-321.

Fowler, E. P., and H. Fletcher 1926 Three million deafened school children. Their detection and treatment. J. Amer. Med. Assoc., 87: 1877-1882.

Fowler, E. P., and H. Fletcher 1928 Three million deafened school children. Their detection and treatment. Further data. J. Amer. Med. Assoc., 91: 1181-1184.

French, N. R., and J. C. Steinberg 1947 Factors governing the intelligibility of speech sounds. J. Acoust. Soc. Amer., 19: 90-119.

Freund, E. M. 1932 Hearing survey, public schools, Albany, New York. New York State J. Med., 32: 791-796.

Glorig, A., and J. Roberts 1965 Hearing Levels of Adults by Age and Sex, United States, 1960-1962. National Center for Health Statistics, HEW, Series 11, No. 11. U.S. Govt. Printing Ofc., Washington, D. C. 34 pp.

Glorig, A., D. Wheeler, R. Quiggle, W. Grings, and A. Summerfield 1957 Some medical implications of the 1954 Wisconsin State Fair Hearing Survey. Trans. Amer. Acad. Ophthal., 61: 160-171.

Goetzinger, C. P., D. D. Dirks, and C. J. Baer 1960 Auditory discrimination and visual perception in good and poor readers. Ann. Otol. Rhino. Laryngol., 69: 121-136.

Hallbäck, M. 1975 Interaction between central neurogenic mechanisms and changes in cardiovascular design in primary hypertension. Experimental studies in spontaneously hypertensive rats. Acta Physiol. Scand. Suppl., 424 pp.

Hanson, D. R., and R. W. Fearn 1975 Hearing acuity in young people exposed to pop music and other noise. Lancet, 2: 203-205.

Harris, J. D. 1967 Relations among after effects of acoustic stimulation. J. Acoust. Soc. Amer., 42: 1306-1324.

Hedstrand, H., B. Drettner, I. Klockhoff, and A. Svedberg 1977 Noise and blood pressure. Lancet, 2: 1291.

Hétu, R., L. Dumont, and D. Legare 1977 TTS at 4 kHz among school-age children following a continuous exposure to a broadband noise. Paper presented at the 94th Meeting of the Acoustical Society of America, Florida, December, 1977.

Hirsch, I. J., and R. C. Bilger 1955 Auditory threshold recovery after exposures to pure tones. J. Acoust. Soc. Amer., 27: 1186-1194.

Hood, W. B., Jr., and L. S. Higgins 1965 Circulatory and respiratory effects of whole-body vibration in anesthetized dogs. J. Appl. Physiol., 20: 1157-1162.

Howell, R. W., and B. P. R. Hartley 1972 Variability in audiometric recording. Brit. J. Industr. Med., 29: 432-435.

International Organization for Standardization 1964 ISO Recommendation R 389. Standard Reference Zero for the Calibration of Pure Tone Audiometers. ISO/R 389-1964 (E). Switzerland, November, 1964.

Jauhiainen, T., A. Kohonen, and M. Jauhiainen 1972 Combined effect of noise and neomycin on the cochlea. Acta Otolaryngol., 73: 387-390.

Johnson, D. L. 1973 Prediction of NIPTS due to continuous noise exposure. AMRL-TR-73-91, Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio pp. 62. AD767205

Johnson, G. F., J. P. Dorst, J. P. Kuhn, A. F. Roche, and G. H. Davila 1973 Reliability of skeletal age assessments. Amer. J. Roentgenol., 118: 320-327.

Jonsson, A., and L. Hansson 1977 Prolonged exposure to stressful stimulus (noise) as a cause of raised blood pressure in man. Lancet, 1: 86-87.

Jordon, R. E., and E. L. Eagles 1963 Hearing Sensitivity and Related Factors in Children. Monogr., Laryngoscope (St. Louis), pp. 5-143.

Kachny, G. G. 1977 Blood pressure in weavers under conditions of industrial noise. Vrachebnoe Delo (4): 107-109 (Russian). (Cited by Welch, 1978)

Keith, R. W., and H. P. Talis 1972 The effects of white noise on PB scores of normal and hearing-impaired listeners. Audiology, 11: 177-186.

Kennedy, H. 1957 Maturation of hearing acuity. Laryngoscope, 67: 756-762.

Kerridge, P. M. T., G. Briggs, and D. P. Choyce 1939 Defective hearing and nutrition in children. Lancet, 2: 781-785.

Kinney, C. E. 1961 The further destruction of partially deafened children's hearing by the use of a powerful hearing aid. Ann. Otol. Rhino. Laryngol., 70: 825-835.

Kodman, F., Jr., C. E. Acuff, and K. G. Stockdell 1957 The incidence of hearing loss in Kentucky school children. J. School Health, 27: 253-258.

Kodman, F., Jr., and G. Sperrazzo 1959 An analysis of one thousand cases of hearing loss in children. Ann. Otol., Rhin., and Laryng., 68: 227-233.

Krasilishchikov, M. I. 1967 The use of individual means of protection from industrial noise in the course of occupational training of textile-workers. Gig. san., 8: 40-42.

Kryter, K. D. 1963 Hearing impairment for speech. Arch. Otolaryngol., 77: 598-602.

Kup, W. 1966 Der Einfloss des Lebensalters auf Entstchung und Progredienz der Larmschwerhorigkeit. Hals-, Nasen-, Ohren-Heilkunde: Wegweiser fur die Fachaerztliche Praxis (Berlin), HNO, 14: 268-272.

Laurer, F. H. 1928 Hearing survey among a group of pupils of Syracuse schools. Amer. J. Publ. Health, 18: 1353-1360.

Lenihan, J. M. A., J. F. Cristie, T. S. Russell, N. M. Orr, M. D. Hamilton, and E. C. Knox 1971 The threshold of hearing in school children. J. Laryng. Otol., 85: 375-385.

Lipscomb, D. M. 1972 The increase in prevalence of high frequence hearing impairment among college students. Audiology, 11: 231-237.

Lipscomb, D. M. 1972a Environmental noise is growing--is it damaging our hearing? Clin. Pediatr., 11: 374-375.

Litke, R. E. 1971 Elevated high-frequency hearing in school children. Arch. Otolaryngol., 94: 255-257.

Macrae, J. H. 1968 TTS and recovery from TTS after use of powerful hearing aids. J. Acoust. Soc. Amer., 43: 1445-1446.

Macrae, J. H. 1968a Recovery from TTS in children with sensorineural deafness. J. Acoust. Soc. Amer., 44: 1451.

Macrae, J. H., and D. N. Brigden 1973 Auditory threshold impairment and everyday speech reception. Audiology, 12: 272-290.

Macrae, J. H., and R. H. Farrant 1965 The effect of hearing aids use on the residual hearing of children with sensorineural deafness. Ann. Otol. Rhinol. Laryngol., 74: 409-419.

Maksimova, L. I., Zh. S. Kanevskaya, and G. F. Kuzmia 1974 Effect of impulse noise on the body of workers (Russian). Gig. san., 11: 92-94. (Cited by Welch, 1978)

Marshall, L., and J. F. Brandt 1974 Temporary threshold shift from a toy cap gun. J. Speech & Hear. Dis., 39: 163-168.

May, D. N. 1979 Freeway noise and high-rise balconies. J. Acoust. Soc. Am., 65: 699-704.

Meinhart, P., and U. Renker 1970 Indicators of morbidity in the heart and circulation as a result of excessive exposure to noise. Zeitschrift fur die Gesamte Hygiene und ihre Grenzgebiete, 16: 853-857 (German).

Mills, J. H. 1975 Noise and children. A review of the literature. J. Acoust. Soc. Amer., 58: 767-779.

National Institutes of Health, USPHS 1938 National Health Survey, 1935-36. Preliminary Reports, Hearing Study Series, Bulletins 1-7. U. S. Public Health Service, Washington, D.C.

Nowak, R., and D. Dahl 1971 Der Verlauf des Larmschwerhorigkeit bie Arbeitern der Werftindustries. Zeitschrift fur die Gesamte Hygiene und ihre Grenzgebiete, 17: 483-488.

Nowak, R., and D. Dahl 1971 Die Larmschwerhorigkeit des Schiffsmaschinenpersonals. Zeitschrift fur die Gesamte Hygiene und ihre Grenzgebiete, 17: 488-492.

O'Neill, J. J., and H. J. Oyer 1971 Applied Audiometry. Dodd, Mead & Co., New York. 368 pp.

Partridge, R. C., and D. L. MacLean 1933 A survey of hearing in school children. Canad. Publ. Health J. 24: 524-529.

Peckham, C. S., and M. D. Sheridan 1976 Follow-up at 11 years of 46 children with severe unilateral hearing loss at 7 years. Child: care, health and development, 2: 107-111.

Pokrovskii, N. N. 1966 On the effect of industrial noise on the blood pressure level in workers in machine building plants (Russian). _Gigiena Truda i Professional 'nye Zabolevaniya_, _10_: 44-46. (Cited by Welch, 1978)

Ponomarenko, I. I. 1966 The effect of stable high-frequency industrial noise on certain physiological functions in adolescents. _Gigiyena i Sanitariya_, _2_: 29-33.

Price, G. R. 1976 Age as a factor in susceptibility to hearing loss: young versus adult ears. _J. Acoust. Soc. Amer._, _60_:886-892.

Rintelmann, W. F., R. F. Lindberg, and E. K. Smitley 1972 Temporary threshold shift and recovery patterns from two types of rock and roll music presentation. _J. Acoust. Soc. Amer._, _51_: 1249-1255.

Roberts, C. 1970 Can hearing aids damage hearing? _Acta Oto-Laryngol._, _69_: 123-125.

Roberts, J. 1972 _Hearing Levels of Children by Demographic and Socioeconomic Characteristics, United States_. National Center for Health Statistics, HEW, Series 11, No. 111. U. S. Govt. Printing Ofc., Washington, D.C. 47 pp.

Roberts, J., and E. M. Ahuja 1975 _Hearing Levels of U. S. Youths 12-17 Years, United States_. National Center for Health Statistics, HEW, Series 11, No. 145. U. S. Govt. Printing Ofc., Washington, D.C. 84 pp.

Roberts, J., and J. V. Federico 1972 _Hearing Sensitivity and Related Medical Findings Among Children_. National Center for Health Statistics, HEW, Series 11, No. 114. U. S. Govt. Printing Ofc., Washington, D.C. 72 pp.

Roberts, J., and P. Huber 1970 _Hearing Levels of Children by Age and Sex, United States_. National Center for Health Statistics, HEW, Series 11, No. 102. U. S. Govt. Printing Ofc., Washington, D.C. 51 pp.

Robinson, D. W., and G. J. Sutton 1978 A comparative analysis of data on the relation of pure-tone audiometric thresholds to age. National Physical Laboratory, Teddington, Middlesex, _UK National Physics Laboratory Acoustics Report Ac 84_, 51 pp.

Roche, A. F., and G. H. Davila 1972 Late adolescent growth in stature. Pediatrics, 50: 874-880.

Roche, A. F., C. G. Rohmann, N. Y. French, and G. H. Davila 1970 Effect of training on replicability of assessments of skeletal maturity (Greulich-Pyle). Amer. J. Roentgenol., 108: 511-515.

Roche, A. F., R. M. Siervogel, J. H. Himes, and D. L. Johnson 1977 Longitudinal Study of Human Hearing: Its Relationship to Noise and Other Factors. I. Design of Five Year Study; data from first year. Technical Report AMRL-TR-76-110, Wright-Patterson Air Force Base, Ohio, 158 pp. AD A-040168

Rodin, F. H. 1927 Conservation of hearing and the hard of hearing child. Calif. & Western Med., 27: 643-647.

Rodin, F. H. 1930 Survey of the hearing of the school children of San Francisco. Arch. Otolaryng., 11: 463-474.

Rossell, B. 1933 Hearing impairment in school children. New York State J. Med., 33: 1387-1389.

Rowe, A. W., and D. W. Drury 1932 Vital function studies. IX. Failure of hearing in the young. A study of a rural community. J. Amer. Med. Assoc., 98: 1539-1542.

Suter, A. H. 1978 The Ability of Mildly Hearing-Impaired Individuals to Discriminate Speech in Noise. EPA 550/9-78-100. U. S. Environmental Protection Agency, Washington, D. C. 99 pp.

Takala, J., S. Varke, E. Vaheri, and K. Sievers 1977 Noise and blood pressure. Lancet, 2: 974-975.

Tsysare, A. I. 1967 The reaction of the cardio-vascular system of adolescents to noise vibration stimulation. Gig. san., 2: 33-38.

Ulrich, R. F., and M. L. Pinheiro 1974 Temporary hearing losses in teen-agers attending repeated rock-and-roll sessions. Acta Otolaryng., 77: 51-55.

Wagemann, W. 1960 Int. Audiol., 6: 40. (cited by Hanson, 1975).

Ward, W. D. 1976 Susceptibility and the damaged-ear theory. In: Hearing and Davis: Essays Honoring Hallowell Davis. S.K. Hirsh, D. H. Eldredge, I. J. Hirsh, and S. R. Silverman (Eds.) Washington University Press, St. Louis, Missouri, pp. 127-137.

Ward, W. D., A. Glorig, and D. L. Sklar 1958 Dependence of temporary threshold shift at 4 kc on intensity and time. J. Acoust. Soc. Amer., 30: 944-954.

Weber, H. J., F. J. McGovern, and D. Fink 1967 An evaluation of 1000 children with hearing loss. J. Speech & Hearing Def., 32: 343-354.

Wishik, S. M., E. R. Kramm, and E. M. Koch 1958 Audiometric testing of school children. Public Health Report, 73: 265-278.

*U.S.Government Printing Office: 1980 — 657-084/436